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A

SYSTEM

OF

PRACTICAL MEDICINE

BY

AMERICAN AUTHORS.

EDITED BY

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VOLUME III.

DISEASES OF THE ALIMENTARY CANAL—DISEASES OF THE PERITONEUM—DISEASES OF THE LIVER AND GALL BLADDER—DISEASES OF THE SPLEEN—DISEASES OF THE PANCREAS—DISEASES OF THE THYROID GLAND—CHRONIC METAL-POISONING; ALCOHOLISM; MORPHINISM, ETC.

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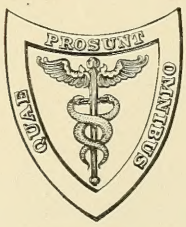

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DISEASES OF THE ALIMENTARY CANAL.

DISEASES OF THE ALIMENTARY CANAL.

DISEASES OF THE MOUTH, TONGUE, TONSILS, PHARYNX, AND SALIVARY GLANDS.

By RICHARD C. CABOT, M. D.

DISEASES OF THE MOUTH.

Stomatitis.

INTRODUCTION.

The salivary glands during the first three or four months of life are very inactive, and the mouths of infants are therefore comparatively dry. Even irritation fails to start any considerable flow of saliva. Hence the great likelihood of accumulation in the mouth of various irritating substances or organisms which in the adult would be washed away by the saliva. Even after the flow of saliva is established, it is less useful than it might be, since it escapes very largely from the lips, and does not carry down irritants to the stomach, where the gastric acids might destroy them.

Again, the habit of carrying everything to the mouth, as young children do, adds to the sources of irritation of that cavity.

Hence it is that we always think chiefly of children when the subject of stomatitis is mentioned.

Catarrhal Stomatitis.

Etiology.—For the reasons given in the preceding section the disease occurs chiefly in infancy. Surroundings are of influence only as they "prepare the soil" for the disease by lessening the general resistance of the system.

We must consider three classes of factors in etiology:

1. An irritant;
2. The condition of the tissues as affected by the general condition;
3. Excretion by the saliva.

1. **Irritants** may be divided into—
   (*a*) Mechanical;
   (*b*) Chemical and bacterial;
   (*c*) Thermal.

(*a*) *Mechanical Irritants.*—The pressure or friction of rubber nipples during sucking, rubbing the gums, especially during dentition, rough cleansing of the mouth, and local irritation from a sharp tooth or in adults from ill-fitting false teeth.

(*b*) *Chemical or bacterial* irritants are brought into the mouth on the surface of articles given to children to chew during teething, especially when such articles are allowed to roll on the floor when not in use. Other things which the child puts into its mouth, with or without permission, may serve as irritants.

Food given when fermenting, very acid food, or anything sticky, such as might remain and decompose in the mouth, may give rise to catarrhal stomatitis in infants. In older persons poor care of the teeth and the resulting caries start an inflammation around the carious tooth. This leads to sparing the parts in chewing, and this to the retention and fermentation of food, accumulation of tartar, and thus to greater inflammation in a vicious circle.

Pus from a perialveolar abscess may start a local catarrhal stomatitis as it flows over the gum.

The acrid fluids which pass through the mouth in persistent vomiting may set up this form of stomatitis.

Abuse of tobacco by smoking and chewing is another not infrequent cause, and similarly red pepper or horseradish may irritate and inflame the mouth.

(*c*) *Thermal* irritants, such as very hot tea, are not rare causes of sore mouth, especially in infants, who do not test the temperature of the tea before it is swallowed.

The influence of a bad hare-lip or cleft-palate in starting a stomatitis may be mentioned here, whether cold is the chief factor or not.

2. The soil on which these irritants are effective is prepared by any disease that lowers the general vitality. Such diseases are tuberculosis, syphilis, diphtheria, malaria, typhoid, the exanthemata, and chronic diarrhœas in childhood. In adults wasting diseases and the rheumatic or gouty diathesis seem to predispose the patient particularly to this affection.

Gastro-enteric disturbances and indigestion have been frequently mentioned as causes of stomatitis, but are probably to be thought of more properly as results or concomitants. Such causative influence as they exert is probably through the changes in the saliva next to be mentioned. It may be that all the diseases spoken of above act in producing stomatitis through diminishing the antimicrobic action of the saliva, or through

3. **The Excretion of Toxic or Irritating Substances by the Saliva.**—Our definite knowledge of such a process is mostly confined to the action of mercury, the iodides, lead, phosphorus, and other inorganic substances, to be discussed more fully in the section upon Ulcerative Stomatitis (page 26). But there is good reason to believe that various organic substances are excreted by the saliva in disease, and thus cause stomatitis.

Boucheron has found uric acid in the saliva, and it is probable that the toxins of various diseases may exert their influence here as well as upon the skin and kidneys.

We have no direct evidence that any special micro-organism is concerned in the production of catarrhal stomatitis.

Finally, it should be mentioned that a rhinitis or pharyngitis extends very rarely to the buccal mucous membrane as stomatitis.

Symptoms and Signs.—Except in the rarer local form of the disease there is no favorite starting-place. The whole mouth shows changes which are in the earliest stages simple erythematous, merging later into the true catarrhal. This early erythema is to be distinguished from the physiological hyperæmia of the mouths of infants during the first week of life, for, although this last may be so intense as to cause slight hemorrhages, it does not go on to genuine catarrhal inflammation. It is also distinct from the passive hyperæmia which gives the bluish tinge to the mouths of children with whooping cough, or any other disease in which the return of blood to the right heart is hindered.

The mouth is red, hot, at first dry, but soon bathed in abundant saliva, and painful. Swelling of the mucosa of the lips and cheeks is present, and if there are any teeth their marks can be seen in the cheeks, lips, or tongue.

In older children the gums around the incisor teeth are very puffy and painful.

Occluded mucous glands show as minute beads above the surface, and rarely the occlusion leads to a retention-cyst. The vessels are so distended that a very slight injury starts bleeding, and slight abrasions of the macerated epithelium of the mucous membrane are common, but rarely involve the deeper layers. Small vesicles may form and burst, leaving shallow ulcers. The tongue is dry and coated white at first; later its edges are cleaned off by the hypersecretion of saliva. The gums are smeared with mucus. In children there is usually an evening temperature of 101°–102° F., with morning remissions. Where continuous fever is present, as in the stomatitis accompanying typhoid or scarlet fever, the whole mouth, and particularly the tongue, becomes denuded of epithelium, dry, fissured, and bloodstained, and sordes collect on the teeth.

The lymphatic glands are swollen, the amount of enlargement corresponding with the severity of the disease.

In adults the complaints are mostly of soreness and salivation, a bad taste in the mouth, and disagreeable odor to the breath. There is little or no fever. Sometimes speech and chewing are painful.

Infants are unwilling to nurse. "The little patient goes at the breast with a good will, evidently hungry; takes one or two pulls, then suddenly lets go the nipple and begins to cry. By a little coaxing he will try again, but the same result follows, and finally the baby absolutely refuses to be put to the breast, preferring to remain hungry to suffering pain" (Forscheimer). The acid saliva flows from the mouth, and often starts an obstinate eczema.

The acute form as seen in children is usually well in one to two weeks, the worst symptoms lasting only three or four days. The chronic form, seen in topers and inveterate smokers, is obstinate.

Prognosis.—In adults the disease is an inconvenience only, but in infants, though usually of no great importance, the disease may even prove fatal by preventing the child from taking food at a time when its

vitality has been greatly reduced by other causes (malaria, the exanthemata, etc.). This is very rare. It should, however, be remembered that a catarrhal stomatitis may set up gastric and intestinal disturbances which are sometimes serious. One attack seems to predispose to another, and in badly nourished "marantic" children the disease may become chronic.

Treatment.—The majority of cases are not treated and recover easily, but, as other and more severe forms of stomatitis may take root on the simple catarrhal mucous membrane, treatment has a certain importance.

In adults the removal of the cause is the chief indication. In regard to infants, the mother should be impressed with the duty of habitually cleaning the mouth several times daily with absorbent cotton dipped in boiled water (lukewarm) and wrapped round the finger. This is the most important element both in prophylaxis and treatment; but gentleness is essential, else more harm than good is done. The form of stomatitis known as "Bednar's aphthæ" is in all probability due to roughness in attempts to clean the mouth. In fever frequent washing of the mouth with cold water or sucking small pieces of ice are pleasant and helpful.

Food should be given cold (except to children at the breast), and the water used for washing out the mouth should also be cold. Feeding should be kept up in spite of the resistance of the child, and if the child is badly nourished at the start and refuses to suck, a carefully modified milk should be given with a spoon or dropper for a few days. Lotions and the use of chlorate of potash are unnecessary.

Ulcerations should be touched with mitigated stick nitrate of silver.

Herpetic Stomatitis ("Aphthæ;" "Canker").

Etiology.—Forscheimer has offered excellent evidence that the disease is a form of *herpes* occurring in the mouth, and differing from ordinary herpes only in such ways as are brought about by the difference in situation. According to him, it is due to the elimination by the saliva of toxic products. Friedrich[1] produced by the injection of the toxins of the streptococcus and bacillus prodigiosus (Coley's) herpes facialis in 7 cases and "aphthæ" in 2 cases.

This does not necessarily exclude the associated influence of bacteria, but most bacteriological investigations in connection with the disease have shown only pus-forming organisms. Looss[2] has repeatedly found what he calls a diplo-streptococcus in connection with the lesions, and Chaumier[3] considers it contagious and epidemic, the lesions being only a local manifestation of a general infection. He succeeded in producing the disease on the mouth and lips by inoculation of the arm with material from other cases. The 107 cases observed by this writer occurred in 21 families in groups of from 2 to 4 cases in a family, but this, of course, does not prove that it is contagious, as the same cause may have produced them all without direct transmission. Evidence

[1] *Berl. klin. Woch.*, 1896, Nos. 49 and 50.
[2] *Mediz. bericht d. Jenner's Kinderspital*, Bern, 1896.
[3] *Nancy Congress*, August, 1896.

has been offered that foot-and-mouth disease in cattle is the same disease as herpetic stomatitis, and, while this cannot be absolutely denied, it has been shown that the transmission does not take place through milk. It may occur independently, or in connection with any febrile disease or digestive disturbance.

It occurs not infrequently in adults as well as in children, and may be very obstinate in neurasthenic conditions and during pregnancy and lactation. In children the debility often associated with the first dentition may be the reason for the frequency of the disease at that period, the tissues being less resistant than normally. A catarrhal stomatitis usually accompanies it, and probably adds to the vulnerability of the mucous membrane.

Pathology and Symptoms.—The spots or aphthæ which characterize the disease form macules rapidly developing into vesicles, and appearing as small, yellowish white, subepithelial spots singly or in groups in various parts of the mouth, but especially on the inner surface of the lips, on the side and under surface of the tongue, on the cheeks, and on the frænum. Less frequently we find them on the gums or in the pharynx. Crops of herpes facialis may accompany the aphthæ.

Usually within twenty-four hours the epithelium is soaked off and a small shallow ulcer remains, the red areola persisting. Several spots may run together to form larger ulcerations. Microscopically, the white spots consist of fibrin and leucocytes in the superficial layers of the epithelium, which is thickened and opaque. After the ulcer has formed and the exudation washed away, we find in the ulcer various saprophytes, but usually no pathogenic organisms.

Within a few days the epithelium is formed anew and no cicatrix is left, though the young epithelial cells are for a time opaque, so that a light spot marks the seat of the ulcer.

Although the individual vesicle lasts but a few days, successive crops usually appear, so that the disease may run on for ten to fourteen days. A few of the vesicles may be absorbed without ever coming to the stage of ulceration. In some adults the process is chronic.

The constitutional disturbance may be very slight or may be severe. The symptoms are the same as those described under Catarrhal Stomatitis—pain, salivation, fever, loss of appetite. The breath is *not* foul, as in the severer forms of stomatitis. The disease appears to be usually self-limited, and a week is the average duration.

Prognosis.—Except in children much reduced by other diseases the prognosis is absolutely good. The only harm done is that the child will not eat well, and loses some strength in consequence. Relapses are rare. In adults, as already mentioned, the disease may be obstinate and inconvenient. In one case observed by the writer a girl of twenty-three was subject to recurrent attacks of herpes facialis with herpetic stomatitis and crops of herpetic vesicles on the palms and soles of the feet. Each attack was accompanied by fever and coryza, and ran a self-limited course entirely unaffected by treatment, ending in about two weeks.

Treatment.—In infants the only treatment necessary is to touch each ulcer with nitrate of silver. Washes and potassium chlorate are unnecessary. As to feeding, what has been said under Catarrhal Stomatitis is sufficient (page 22).

In adults our attention should be directed to improving the general health as far as possible. Rest, change of air, outdoor exercise, and tonics are indicated. Silver nitrate will heal the single "canker sore," but has no tendency to prevent its recurrence.

The name of "*Bednar's aphthæ*" is associated with small, shallow ulcers occurring on the hard palate near the velum palati, and sometimes on the soft palate, due, as above indicated, to roughness in cleaning the mouth. They heal readily without treatment. Such lesions are rarely seen in this country.

Mycotic Stomatitis (Thrush).

Etiology.—Authorities differ as to whether the thrush fungus belongs to the class of yeast fungi or to that of moulds. It is probably not the oïdium albicans, as has been long supposed. It is found in threads (mycelium) or spores, one or the other predominating according to the structure of the tissue in which it grows.

The fungus has been found on various mucous membranes, respiratory as well as alimentary, and in the genito-urinary tract as well as in the lungs, the brain, and in the bloodvessels.

It has a preference for flat or squamous epithelium, such as that in the mouth and pharynx, but is by no means confined to these localities. (See page 25.)

Rarely, the disease develops in the mouths of perfectly healthy children (Epstein; Forscheimer), but usually it is found in those who are enfeebled by disease or neglect, and whose mouths are consequently in a condition of catarrhal stomatitis. Children are most liable to it during the first two or three weeks of life, but it may occur at any age, and is occasionally seen in wasting diseases of adults (diabetes, tuberculosis).

The parasite may be carried by the nipple of the mother from child to child, or by the rubber nipples of feeding-bottles not properly cleaned, or by the fingers of the nurse. Hence epidemics formerly occurred in foundling hospitals, etc.

Forscheimer points out that, owing to its method of growth in the tissues, it takes root best where it is least disturbed,—hence in subjects who move their tongues least, which helps to explain its frequency in very young children and cachectic diseases of adults. It will also be noted that these two classes of patients are alike in living chiefly on milk diet.

Pathological Anatomy.—The disease usually appears on the tip of the tongue as white, raised, pearly dots on the mucous membrane. These grow rapidly and soon join to form large patches, and may spread to the cheeks, lips, pharynx and larynx, trachea, gullet, and even into the lungs and stomach. From their growth into the bloodvessels metastases may take place, as in the brain (Zenner) or in the kidney (Schmorl), but this is very rare.

In the gullet the growth may be so luxuriant as to occlude the tube. Heller found thrush in the gullet of 17 out of 18 autopsies in which the gullet was examined, 7 times in the larynx, 4 times in the lung, and once in the stomach.

The little white spots on the tongue with which the disease begins

can sometimes be scraped off without hurting the mucous membrane, and sometimes leave a bleeding surface if removed. These thrush patches are composed of buds and threads of the fungus, together with cast-off epithelial cells, bits of food, and fibrin. They very closely resemble a bit of curdled milk, and may be mistaken for such. According to the nature of the food or medicine taken the thrush patch may be gray, brown, or even black.

The fungus begins its growth between the layers of epithelium in the form of spores without mycelium. As it develops it separates the strata of epithelium and grows upward and downward. The superficial layers are killed and cast off. Mycelium threads are developed abundantly in the direction of the connective tissue, and in a lesser degree on the free surface.

It has been supposed until recently that the fungus rarely penetrates below the epithelium, but the studies of Heller[1] prove that this is not the case. His examination of 33 thrush growths in 25 autopsies showed that in only 12 per cent. was the growth confined to the epithelium, while in 88 per cent. it penetrated deeper. Of 18 cases with lesions in the gullet, 16 had penetrated to the connective tissue, 9 to the connective tissue and vessels, and 1 to the muscular layer.

Around the fungus growth we find areas of necrosis and round cell infiltrations, but no pus. These evidences of irritation are usually of a very transitory nature, and soon disappear when the fungus is removed; but Heller has found it in foci of broncho-pneumonia and in ulcerations of the gastric mucosa.

Symptoms.—Although it is possible for a healthy child to become infected with thrush, the vast majority of cases occur in weakened and debilitated patients, and in such patients it may be difficult to distinguish the symptoms due to the thrush from those of the underlying condition. In some cases there are no symptoms at all, and the patches are discovered accidentally. The local symptoms may be those of a mild catarrhal stomatitis, but the tissues round and under the membrane show little if any evidence of reaction against the parasite. Pain is present only when the deeper tissues are involved; if the growth spreads to the tonsils, we may have a tonsillitis with swelling, pain on swallowing, and even absolute refusal of food. Sometimes ulcerations form at the point where a patch of thrush has dropped off, which may be filled up again with the parasitic growth or remain as obstinate, sometimes chronic, ulcers.

In severe cases we may have fever, swelling of the glands at the angles of the jaw, and general constitutional disturbance. Rarely the growth in the gullet may be so abundant as to cause obstruction and prevent swallowing. The plug is sometimes expelled by vomiting. Gastro-intestinal disturbances are common in severe cases, probably owing to the large quantities of the parasites and its products which are swallowed.

Eczema of the nates is a frequent complication. If not properly treated, the disease may last indefinitely.

Prognosis.—The chief source of danger, aside from the rare occurrence of obstruction of the gullet, is malnutrition. In patients not

[1] *Deutsch. Arch. f. klin. Med.*, 1896, vol. iv. p. 123.

much debilitated and promptly and properly treated, the disease is not a serious one. But where the vital forces are already much impaired by inherited or acquired disease, the hindrance to proper nutrition occasioned by thrush may prove a serious complication.

In general, the affection is worse in very young children, and the extent of the growth is a measure of the severity of the disease.

TREATMENT.—Prophylaxis is highly important. In hospitals or asylums, cases of thrush should be isolated. Cleanliness of the mouth, and especially of the mother's nipples and the nipples of nursing-bottles, will do much to prevent the occurrence or spreading of the disease. All feeding utensils should be boiled after each feeding.

Aside from prophylaxis, the treatment is largely the patient, mechanical removal of the growth. This is best done with an alkaline solution (lime water, sodic bicarbonate 1 : 20). Dip a rag in this solution and wipe off all that can be seen of the growth. This should be done several times a day, as often as the spots form. A moderate amount of violence is necessary. It is unnecessary to use any other remedy, and the use of honey should be scrupulously avoided. Ulcerations may be touched with nitrate of silver. Some cases are very stubborn and resist treatment for a long time.

Constitutional treatment is important. In stubborn cases a change of air should be tried, and careful regulation and cautious changes of diet are sometimes of service.

Grösg,[1] who has recently studied an epidemic among the newborn, which remained endemic with frequent relapses, thinks that the prophylactic cleansing of the mouth of newborn babies predisposes to thrush by removing the superficial epithelium and providing the fungus with its favorite soil. He finally controlled the disease and reduced the number of cases from 32 per cent. to 9 per cent. of the newborn children by wiping out the mouth once daily with 3 per cent. silver nitrate, as well as frequently removing the growth as above indicated.

Ulcerative Stomatitis (Stomacace; Putrid Sore Mouth).

ETIOLOGY.—If mercurial stomatitis be taken as the type of this disease, the chief factor in etiology is evidently the eliminative function of the saliva. The importance of this view, which has already been alluded to, has been strongly emphasized by Forscheimer.[2] Elimination by the saliva of substances like mercury, iodine, lead, arsenic, antipyrine, and possibly bacterial products, produces a soil in which the ordinary bacteria of the mouth can set up a variety of pathological processes.

A striking fact about the disease is that it occurs only where there are teeth, and affects chiefly the gums around the teeth. This is probably due to the fact that the unknown irritant or organism which attacks the diseased mucous membrane accumulates best around, and especially between, the teeth.

The disease has repeatedly occurred in endemics under conditions of bad hygiene, but is not contagious. No specific micro-organism has been found. It is most common in children between five and ten years

[1] *Jahrb. d. Kinderheilk.*, 1896, p. 177. [2] *Journal of Pædiatrics*, Jan., 1897.

old, but rarely attacks those who are otherwise healthy. Measles, scarlet fever, malaria, typhoid, pneumonia, and whooping cough among acute diseases, and syphilis, tuberculosis, and rickets among chronic diseases are especially apt to be complicated with ulcerative stomatitis.

Children who are neglected and whose mouths are not cared for are often attacked by it. The accumulation of tartar, and carious teeth, are thought to predispose to it, but are more likely to be due to the same cause that produces the stomatitis.

Pathological Anatomy and Symptoms.—The disease always begins at the free border of the gums, and thence extends in all directions, but is usually confined to the gums and the parts immediately adjacent—viz. the borders of the tongue and the parts of the cheek opposite the teeth. The teeth on the lower jaw, and especially the incisors, are first affected.

Swelling is the earliest symptom, and is first seen in the portion of the gums covering the anterior aspect of the teeth. The gums between the teeth and the posterior aspect of the gums are rarely affected, except in very severe cases. The swelling may be so great as nearly to cover the teeth. The cheek-pockets adjacent show indentations from the teeth.

Injection of the swollen gums is so great that the overfilled vessels bleed at the slightest touch, and even from a movement of the jaw. Tenderness on pressure is usually marked. Detachment of the gums from the teeth soon follows, the cavity being filled with muco-purulent secretion.

The stage of ulceration follows. A yellowish band or line of spots appears along that part of the gums first affected. This represents an epithelial necrosis, and covers an ulcerated surface bathed in sero-purulent fluid. If left to itself, the ulceration spreads until the whole tooth is denuded, falls out; bone-necrosis follows, and small sequestra are separated from the stripping up of the periosteum of the alveolar process.

The lesions extend downward into the tissues with great rapidity, but spread over the surface much more slowly.

Infection of the cheeks, tongue, etc. takes place chiefly by direct contact and with lesions similar to those on the gums, but we sometimes find ulcerations in the fold between the gum and cheek, with healthy tissue between them and the original lesions, as if the *materies morbi* had *dropped* down by gravity.

The most striking symptoms are the horrible *foulness of the breath* and the *salivation*, which is profuse. The saliva is generally odorless. There is difficulty in chewing, swallowing, and speaking.

In older children constitutional symptoms may be slight in spite of extensive ulceration; sometimes they are severe. The appetite is poor and nutrition suffers. Pain in the mouth may be very severe, and in young children a great deal of sleep is lost.

The lymphatic glands are usually swollen, and may remain so after the disease is cured.

Prognosis and Course.—If proper treatment is begun before the disease has reached an advanced stage, the outlook is for a prompt and complete recovery within seven to ten days. Rarely cases have been known to recover without treatment. When recovery begins the fetor

and salivation diminish, the pulpy yellow covering of the ulcer is thrown off, and new epithelium is formed over the seat of the ulcer.

Rarely a milder but chronic form of the disease is seen, probably identical with what the dentists call shrinking of the gums, but this form finally recovers.

When secondary to such diseases as syphilis or rickets, it may be impossible to cure the stomatitis until the underlying disease is conquered.

The possibility of a gangrenous stomatitis ("*noma*") arising from ulcerative stomatitis must be recognized, though the occurrence is rare.

TREATMENT.—Chlorate of potash is a wonderfully effective though somewhat dangerous remedy. It has decided toxic effects in overdose, and is very painful to swallow, owing to the ulcerations over which it must pass. On account of this pain it is best given internally, and local applications in powder or as mouth-wash are not as desirable.

Rotch gives the following table of doses:

Amount of Chlorate of Potassium which can Safely be Given in Twenty-four Hours.

Age.	
Under 1 year	15 grains.
1 to 2 years	20 "
2 to 6 "	30 "
6 to 8 "	40 "
8 to 14 "	45 "

Drowsiness, dark urine of small amount, and weakness of the heart should always be watched for when giving chlorate of potash, and should these symptoms appear the potash should at once be stopped. It is best given in solution at short intervals through the twenty-four hours.

In most cases so great an improvement in the lesions takes place within thirty-six to forty-eight hours that the pain from swallowing the potash ceases, and the other symptoms rapidly ameliorate.

Rapid recovery is often followed by relapse, and the slightest evidence of returning ulceration should be watched for. Should such occur the potash should be begun again at once.

Where chlorate of potash does not rapidly affect the lesions nitrate of silver should be used in the usual way several times a week. Mikulicz advises the use of iodoform paste on the ulcerations and lays strips of iodoform gauze between the lower teeth and the cheeks.

The general condition of the patient should be cared for in every possible way. The child should stay outdoors, weather permitting, a considerable part of each day. Food should be regularly administered despite any pain which it may cause, and the mouth should be washed out with sterile water after each feeding. It may be necessary to feed through a nose tube and by rectum if the child cannot be made to swallow.

Gangrenous Stomatitis Noma (Cancrum Oris).

Fortunately, this terrible disease is a rare one, and apparently, like hospital gangrene, it is growing rarer. It consists of a gangrene of the

cheek beginning on the inner side near Steno's duct and spreading with great rapidity.

Etiology.—No specific micro-organism has been isolated, and there is no satisfactory evidence of its infectious nature. It is not contagious. It is safe to say that the disease never occurs except in children whose vitality is reduced by previous illness.

Measles has immediately preceded the gangrene in nearly one half the cases on record. Other diseases, such as typhoid, scarlet fever, pneumonia, and many more, are more rarely antecedent.

Ulcerative stomatitis has repeatedly been observed to develop into noma.

It is a disease of children. Of 413 cases collected by v. Bruns,[1] only 11 occurred after the fifteenth year, and only 6 in young infants. Most cases occur between the third and seventh years.

Pathological Anatomy and Symptoms.—Almost all cases begin in the same place—viz. on the inside of the cheek between the corner of the mouth and the opening of Steno's duct, opposite the first or second molar. A bluish red vesicle forms, which rapidly becomes black or greenish black. The cheek for some distance outside the lesion is swollen and brawny, with a waxy pallor which soon spreads over the whole side of the face. The process is one of typical moist gangrene, and advances with frightful rapidity. The gangrenous area soon begins to show on the outside of the cheek, and is surrounded by a red areola.

Usually the earliest symptom which calls attention to the disease is the peculiar smell of gangrene. The flow of saliva and ichorous fluid is profuse and horribly fetid.

If untreated, and often in spite of treatment, the disease spreads so as to perforate the cheek, and goes on to destroy the nose, the eye, the frontal bone, while in the mouth the bones are laid bare, the teeth fall out, and the soft palate and tonsils may be involved. The process may run down the neck and along the supraclavicular fossa and backward beyond the ear.

Occasionally, as in a case seen by Forscheimer, the disease may suddenly stop before it has progressed far, leaving a clean-cut hole in the cheek. In such cases the line of demarcation becomes broader and of a brighter red, the surrounding infiltration disappears, and the gangrenous slough is separated by vigorous granulations; bone sequestra are cast off, and cicatrization with enormous scars takes place.

Relapses are rare. The total duration of fatal cases is usually from one to two weeks, perforation of the cheek often occurring within twenty-four hours. Acute cases are of short duration, and chronic cases rarely occur.

Subjective symptoms are sometimes very slight, the child remaining bright and interested in play, and taking food well as long as swallowing is possible. Diarrhœa is, however, almost invariable, due to the swallowing of gangrenous products. Sooner or later fever and grave constitutional disturbances are developed, food is refused, and the child dies of exhaustion. The mind is often clear to the end and pain is rarely severe. Sometimes there is stupor or delirium.

[1] *Handbuch des praktischen Chirurgie*, Zweite Abtheilung, 1. Band.

Broncho-pneumonia, probably by inhalation of gangrenous matter, is a common complication. The lymph glands are greatly swollen, and albuminuria is the rule. Hemorrhages are rare.

Diagnosis.—Anthrax is to be excluded by its etiology, its greater constitutional disturbance, and the recognition of the anthrax bacillus. A local ulceration produced by a decayed tooth may give a very foul odor and considerable infiltration of the cheek. The course of the case will soon decide the question, the appearance of true gangrene rapidly following where noma is present.

Prognosis.—Very prompt and early surgical interference, with extensive extirpation of the infiltrated as well as the gangrenous parts, may save the patient. Without early and radical treatment almost all cases die, and after the disease has perforated the cheek treatment is usually ineffectual. The mortality is from 70–90 per cent.

Treatment.—The gangrenous tissues being removed, an area of apparently healthy tissue around them should be burnt out with the Paquelin cautery. The wound should be carefully watched for the slightest sign of returning gangrene, and another operation done if necessary.

The nutrition should be maintained at the highest possible level, and the child should be kept in the open air as much as possible.

DISEASES OF THE TONGUE.

Glossitis.

1. Acute Glossitis.

A rare affection, usually due to the stings of insects, burns, traumatism, or foot-and-mouth disease. The tongue has an enormous power of resistance to pathogenic bacteria, and abscess does not often occur. It is occasionally seen affecting the superficial part of the dorsum near the base, starting as furuncles do on the skin, and giving rise to pain and increase in the size of the tongue. Deep abscesses are very rare, and occur chiefly as complications of a severe stomatitis or from wounds (fishbones, etc.), and occasionally in typhoid, erysipelas, variola, and anthrax.

Pain, salivation, and enlargement of the tongue, with difficulty in speaking and swallowing, are the chief symptoms. The tongue often becomes too large for the mouth and protrudes. Œdema of the palate, pharynx, and glottis may occur and constitute a dangerous complication.

Fluctuation is rarely to be obtained even where pus is present.

Fever, anorexia, headache, and other signs of a general infection may be seen.

In the diagnosis one must exclude the passing inflammatory exacerbations which occur in diffuse hypertrophy or lymphangioma of the tongue. Syphilitic gummata sometimes are mistaken for abscesses, but the history and other evidence of syphilis, and the absence of pain and fever, usually put one on the right track.

Treatment.—Scarification and the application of iodoform gauze

are the most efficient remedies. Ice and cooling mouth-washes are rarely of use.

2. Chronic Glossitis.

Repeated attacks of acute inflammation may lead to a chronic enlargement of the tongue, with salivation and possibly ulceration of its edge from the pressure of the teeth. A similar state of things is occasionally seen in myxœdema and cretinism. Speaking and swallowing are difficult.

The TREATMENT is that of the underlying disease.

This condition is to be distinguished from congenital enlargement of the tongue or lymphangioma of the tongue, which is the most frequent cause of what is known as—

Macroglossia.—Besides the lymphangioma of the tongue, the organ may be enlarged purely by muscular hyperplasia, even to three times its normal size, its shape and surface remaining normal. Occasionally only one half of the tongue is enlarged in such cases, and is then associated with hypertrophy of the whole corresponding half of the body. Another rare cause of muscular macroglossia is acromegalia.

The so-called **lobed or fissured tongue** may be of such a size as to come under the head of macroglossia. It is a congenital condition.

As above mentioned, an acute glossitis may supervene in any of these forms of enlargement of the tongue, especially the cavernous lymphangiectatic form.

The TREATMENT of all such affections is purely surgical. Wedge-shaped pieces can be removed until the tongue is reduced to a more manageable size.

Geographical Tongue (Lingua Geographica, Mapped Tongue).

A loss of epithelium in spots and patches, bounded by sinuous white outlines which appear and disappear with great rapidity and suggest the appearance of the boundaries and mountain-chains of a map. The patches are smooth and red, and the papillæ at the borders of the denuded areas are white and prominent and catch the eye. The appearances vary almost from hour to hour, and the whole may temporarily disappear, and appear again within forty-eight hours. Occasionally similar outlines are seen on the cheeks and lips.

The CAUSE of the affection is unknown, and it gives rise to no symptom unless the mind of the patient begins to dwell upon the process and fears of syphilis are entertained. It runs a chronic course and is not affected by treatment.

It should be distinguished from the mucous patches of syphilis, which never wander about or change their shape with such rapidity. It is not at all uncommon at any age, but may go unnoticed for years or for life.

Leucoplasia Buccalis (Ichthyosis, Keratosis, and Psoriasis of the Tongue; Smoker's Tongue).

A disease of the surface of the tongue of obscure etiology and chronic course, characterized by sharply circumscribed white patches of cornified epithelium heaped up so as to form flat raised patches. It is not confined to the tongue, and occurs occasionally on the lips and cheeks.

These accumulations of epithelium are accompanied by a round cell infiltration of the underlying mucosa. Occasionally the patches become detached at their edges or entirely, leaving deep cracks or small denuded surfaces.

Syphilis and smoking have been by some observers held responsible for the disease, but it occurs in many who have never had syphilis and is entirely unaffected by antisyphilitic treatment. While the disease hardly ever occurs in women and is repeatedly observed in excessive smokers, it is also found in men who have never smoked, and it is asserted that it hardly ever occurs in women in countries where they smoke as much as men.

As a rule, the symptoms are trifling, and the disease may be accidentally discovered. Rarely pain from deep cracks or slight trouble in speaking and chewing are complained of. It sometimes annoys patients with a vague sense of something unnatural in the mouth, and they half consciously make effort with the tongue or cheek to rub off the patches, and are so constantly reminded of the existence of the patches. Hypochondriacal fears of syphilis or cancer are not infrequent, and, in fact, the possibility cannot be denied that cancer may develop from such patches. This is the only point of view from which the disease is of importance.

It should be distinguished from the mucous patches of syphilis and from the mapped tongue. The history of syphilis, the seat of the lesions, and the effects of antisyphilitic treatment enable us to exclude mucous patches, while the rapid changes in the looks of a mapped tongue and the white border round a denuded surface easily distinguish the latter from the buccal leucoplasia.

As above mentioned, the disease runs a very chronic course.

Treatment.—In view of the possibility of carcinoma and the tendency to hypochondriasis, it is best to treat every case surgically when the diagnosis is established. The patches should be curetted away and the subjacent mucosa cauterized. The danger of cancer is probably thereby averted and the basis for hypochondriasis somewhat weakened, though the tendency may still be very marked after the removal of the lesions.

DISEASES OF THE TONSILS.

Acute Follicular Tonsillitis.

Synonyms.—Acute catarrhal angina; Acute amygdalitis; Croupous tonsillitis; Lacunar tonsillitis.

This is a disease with which most people have had personal experience.

Etiology.—(*a*) The soil; (*b*) bacteria.

(*a*) The Soil.—*Young adults* are most often attacked. In children the chronic form of tonsillitis (with acute exacerbations from time to time) is the rule, and in the aged acute tonsillitis is impossible, because there are no tonsils to be inflamed, owing to the general atrophy of the lymphoid tissue about the throats of old people.

Sex is of no importance.

Spring and Autumn are the times when we see most cases, whether this be due to conditions of temperature or to conditions of work and occupation, or to other causes.

It seems as if one attack predisposed to another, the tonsils perhaps never becoming quite normal in the interval.

Debility from any cause certainly predisposes to tonsillitis. We see many cases among medical students in the dissecting-room and among hospital internes. Overwork, loss of sleep, sexual excess, and the depression of the menstrual period act in the same way. During the past winter I have seen a number of cases occurring just at the menstrual period, and passing off with the cessation of the flow.

Epidemics certainly occur, and frequently several members of a household are attacked one after another. It is difficult to decide in such cases whether we are dealing with real contagion or whether the disease is endemic.

The disease is often attributed to "catching cold." In my opinion it is rare for the temperature to play any important part in the causation of a case. In a debilitated person a thorough chilling may still further lower the vital resistance of the tissues and allow bacteria to set up pathological processes in them, but in most instances the temperature would have had no effect but for the existing debility.

By *extension* the disease is said to be set up by a coryza, pharyngitis, or stomatitis, but this is not common.

Rheumatism has been supposed by many writers to be often associated with acute follicular tonsillitis, as well as with quinsy and other affections of the tonsil. It has even been asserted that we may see endocarditis complicate cases of tonsillitis as it does cases of rheumatism.

Scarlet Fever, and less often the other exanthemata, are very apt to be complicated by an acute tonsillitis.

(*b*) **Bacteria.**—Goodale has recently shown that in acute lacunar tonsillitis the number of bacteria normally present in the crypts is greatly increased, but that they frequently do not enter the tonsillar tissues, owing perhaps to the resistance they meet from the phagocytes of the glands. "The possibility is at once suggested that the inflammation of the tissues may be due to the absorption through the mucous membrane of irritating toxins formed in the crypts as in a test tube."

Be this as it may, there is no reason to doubt that bacteria are associated with all cases of tonsillitis. As a rule, they are those varieties found ordinarily in healthy throats—*i. e.* the pyogenic cocci and the diplococcus lanceolatus.

Vent,[1] Jaccoud,[2] and others have maintained that those cases in which the diplococcus lanceolatus is obtained in pure culture are apt to be characterized by a violent onset with chill and by a sharp defervescence, reminding one of croupous pneumonia. In such cases a membrane may or may not be present on the tonsils, but in most cases of membranous angina it is a streptococcus which is found. Some of these cases run the course of a very severe septicæmia, hence the term "*septicæmic angina*" has been applied to them. In this group probably belong

[1] Vent: *Inaug. Dissert.*, Greifswald, 1895.
[2] Jaccoud: *La Bulletin Méd.*, Sept. 13, 1896.

those cases described as "the white throat of the lake region" by Genf, and recently by Greene [1] and Tidey.[2]

Many of the pseudo-membranous anginas occurring on or about the fourth day in scarlet fever are associated with the presence of the streptococcus. Thus Lemoine,[3] in a study of 168 cases of angina, 112 of which complicated scarlet fever, found the streptococcus in every case. In 142 out of 145 cases in which he took his cultures from the interior of the tonsil he found the streptococcus *in pure culture*, while in 11 out of 23 cases in which the cultures were taken from the surface of the tonsil other organisms were present besides the streptococcus (a staphylococcus, the diplococcus lanceolatus, or one of the colon bacillus group).

Most cases of suspected diphtheria where the Klebs-Löffler bacillus is not found show streptococci. The virulence of these organisms is often much greater than that of the streptococci found in healthy throats.

Pathological Anatomy.—Three types may be distinguished: (*a*) The erythematous or catarrhal; (*b*) The lacunar; (*c*) The pseudo-membranous.

(*a*) The main features of these types are usually found in all severe cases, though one or the other may predominate. If erythema predominate, we see a more or less vivid reddening of the tonsils, pillars, soft palate, and uvula, all of which may or may not be swollen as well.

(*b*) In most cases we find also several yellowish white spots on one or both tonsils, the spots corresponding to the orifices of the gland-crypts, which are plugged up by an accumulation of degenerated leucocytes, epithelium, and bacteria in a meshwork of fibrin. These cheesy plugs can be picked off or pressed out, and are not adherent to the subjacent parts. The exudations of contiguous lacunæ may coalesce, and most of the tonsil may thus be covered, so that the appearances of diphtheria are strongly suggested; but, as a rule, the deposits do not form a continous layer. The parenchyma of the tonsil is infiltrated with serum and leucocytes, increasing its bulk.

The affection may be unilateral or bilateral. Very often first one tonsil and then the other goes through the process.

In the severer cases the glands at the angle of the jaw are swollen.

Occasionally the cheesy plugs, instead of being pushed out in a few days, are retained and become calcified. The chalky masses may later be expectorated—"timid persons may be badly frightened, believing them to be tubercles." Again, the follicles may become occluded and small abscesses result.

(*c*) *Pseudo-membranous tonsillitis* is also known as necrotic tonsillitis, gangrenous tonsillitis, aphthous tonsillitis and diphtheroid sore throat. The two latter terms are misleading, and should not be used, since it has no connection with aphthæ, and the most important fact about it is that it is not diphtheria.

We have here a superficial necrosis which may or may not become gangrenous. A grayish white membrane, exactly like that of diphtheria, spreads over the tonsil and may involve the soft palate, uvula,

[1] *N. Y. Med. Rec.*, Feb. 15, 1896. [2] *Ibid.*, April 11, 1896.
[3] *Annales de l'Institut Pasteur*, 1896, vol. ix. No. 12.

and even the pharynx. It is not detachable, or if detached leaves a bleeding surface. The process may extend quite deep into the structure of the mucous membrane.

This form of sore throat is seen most often as a complication of scarlet fever, but is occasionally seen as a primary disease. The evolution of the membrane takes four or five days, after which it is *usually* not reproduced.

Bacteriologically, the important point is the absence of the Klebs-Löffler bacillus. Other bacilli closely resembling it are sometimes found in such throats, and to them the name of pseudo-diphtheritic bacilli has been attached. The term should never be used. Competent observers can distinguish the Klebs-Löffler from all other bacilli, including this variety. It is true that the virulence of the Klebs-Löffler bacillus varies widely in different cases, but this is true of many bacteria, and there is no reason for giving another name to the weakly-virulent races.

The streptococcus is the organism most often found in necrotic tonsillitis, either alone or in connection with a staphylococcus or the diplococcus lanceolatus. Occasionally one of the latter varieties is found in pure culture. In the severe septic cases the organs may show the changes common to many forms of septicæmia—granular degeneration of the heart, liver, and kidneys, metastatic processes in various organs, ulcerative endocarditis, and other lesions.

Moure of Bordeaux makes out a separate disease called "herpetic tonsillitis," in which, after becoming red and swollen, the tonsils present a crop of herpetic vesicles, which are also to be found scattered over the neighboring parts of the throat. In from twelve to thirty-six hours the vesicles break, leaving little ulcers covered with whitish exudation. The majority of observers find these lesions in connection with other forms of tonsillitis, and do not recognize a separate affection.

Symptoms and Signs.—1. *Symptoms and Signs of a General Infection.*—1. In some cases constitutional symptoms are so slight that the patient is scarcely aware of any, but, as a rule, he experiences more or less lassitude and malaise, which in bad cases may amount to severe prostration and great fatigue on any muscular or mental effort.

Headache, and pain and soreness "in the bones" or "all over," are the rule, and may be very severe, coming on suddenly and violently or gradually increasing for a day or two. Delirium has been observed, especially in children.

The appetite is usually poor and the tongue coated; vomiting sometimes occurs, and there may be constipation or more rarely diarrhœa.

Fever is almost invariably present, often reaching 102°, and not infrequently rising to 104 or 105° F., especially in children. Chilly feelings at the time of the onset are the rule, and occasionally there is a genuine chill.

The pulse is correspondingly elevated, and the respiration is often rapid even where cough and affections of the lung are entirely absent. This is especially apt to be the case in young children. At the height of the fever an apex systolic murmur is not uncommon, but is no indication of endocarditis.

There is no characteristic type of fever. Onset and defervescence

may be alike abrupt or one or both may be gradual. As a rule, the fever is continuous with moderate morning remissions and evening exacerbations. From three to six days is the average duration. If the disease crosses over to the other tonsil, the whole course may be repeated. The fever is usually over before the local lesions are gone, and in children it may last but twenty-four hours or even less.

The urine is that of fever—high color and specific gravity, with now and then a trace of albumin and a few hyaline or granular casts.

The spleen is occasionally enlarged.

Leucocytosis is always present in marked cases, and may run as high as in diphtheria or pneumonia.

The above symptoms and signs of a general infective process are, as a rule, much more marked than the extent of the local process would lead us to expect. This is especially true in young children, in whom throat lesions may be found only in the course of routine physical examination.

As in grippe, patients are amazed to find themselves feeling so sick with so little to show for it.

2. *Local Symptoms and Signs.*—Tickling, burning, or "scratchy" feelings in the throat are usually the earliest. Pain is present on swallowing or occasionally on speaking, but not, as a rule, when the parts are at rest, except in very severe cases. Salivation is not infrequent. The voice is often altered, and may have a nasal twang or be muffled.

Movements of the head and neck are often painful, even when the cervical lymph glands are not involved, and there may be stiff neck or actual torticollis. Sometimes the pain on swallowing shoots to the ear without there being any involvement of the Eustachian tube or middle ear, but these parts are occasionally involved by extension.

Cough is not usually troublesome unless pharyngitis is also present, and in many cases there is none at all.

Examination shows usually redness and swelling of one or both tonsils, with one or more yellowish-white spots on them, varying from the size of a large pinhead to that of a split pea. These can be easily stripped off or poked out, leaving an intact mucous membrane beneath.

These are the appearances in the great majority of cases, and it is in these cases that clinical observations can usually anticipate the results of the bacteriological examination (which should be made in every case), and distinguish the disease from diphtheria. Where a widespread membrane is present the bacteriological examination alone can decide whether it is or is not diphtheritic. Still, it remains true that the vast majority of membranous throats are diphtheritic, and the vast majority of those showing only spots at the orifices of the tonsillar crypts are *not* diphtheritic, the bacteriological test remaining the ultimate one for diagnosis.

The exudate of tonsillitis is usually patchy, with sound tissue intervening, seldom extends beyond the tonsils, can be stripped off, leaving an intact surface beneath, and does not give the impression of necrosis. Diphtheritic lesions, usually not patchy, do extend beyond the tonsil and cannot be stripped from the surface, since they represent a necrosis of its superficial layers.

The breath may be foul, but the strong gangrenous odor often noticed in diphtheria is not present.

Herpetic vesicles are occasionally seen on the tonsils, with or without other lesions. They may occur in crops.

The appearances of pseudo-membranous tonsillitis have already been described (Vol. I. pp. 708–710). They are identical with those of diphtheria, and the extreme fetor of the breath and adeno-phlegmon of the neck are as frequent as in the latter disease.

In scarlet fever membranous angina may occur near the beginning of the disease or in convalescence. The latter (according to Moure) are almost always diphtheritic, the others rarely so.

Course and Prognosis.—After forty-eight hours the worst symptoms are usually over. The forms due to the diplococcus lanceolatus are said to be very abrupt in onset and termination, and Moure holds similar views in regard to the "herpetic tonsillitis" described by him.

Except in the fulminating septicæmic forms, which are rarely seen, the prognosis as to life is entirely good. Some of the pseudo-membranous throats seen in scarlet fever do serious mischief by extension to the nose, ear, or larynx.

Bassford asserts that after "rheumatic tonsillitis" we may see an endocarditis develop. Hague-Brown in an analysis of 345 cases found that 8 had endocardial lesions ending in valvular disease, and 3 had pericarditis. Gougenheim records a case of membranous angina due to streptococcus in which purulent pericarditis, empyema, and suppuration in the sterno-clavicular joints occurred and caused death from general septicæmia. Suppurative tonsillitis is not very uncommon as a complication, especially in those who have had previous suppurative attacks. Osler regards paralysis, local or general, following "tonsillitis" as indicating that the diagnosis was wrong and the case really one of diphtheria. Moure, Bosworth, and Strümpell, on the other hand, consider that paralyses similar to those following diphtheria have occurred after genuine non-diphtheritic angina. Personally I have never seen such.

Nephritis is very rarely if ever a complication.

Treatment.—Until diphtheria is positively excluded patients should be isolated. After that it is unnecessary. The disease is self-limited, and cannot be aborted or much shortened by any means known to us.[1] In the great majority of ordinary lacunar cases no local treatment is necessary. If fever is present, the patient had better go to bed. A laxative should be given in case of constipation, not otherwise. The headache, soreness, and general discomfort are often greatly relieved by phenacetin, which can be given in doses of 10 grains combined with 2 grains each of caffeine and sodic bicarbonate. Such a powder may be given to an adult two or three times in twenty-four hours for the first day or two, if needed, and will serve to keep the temperature moderate and allay the discomforts of high fever, as well as the pain and muscular soreness. Quinine has no action unless given in doses sufficient to

[1] A possible exception to this statement is the use of Marmorek's antistreptococcus serum, which in the hands of Dubois (*Bull. Méd. du Nord*, April 10, 1896) is said to have caused marked improvement, local and general, in 4 cases of scarlatinal angina.

reduce temperature, and there is no reason for giving iron. My experience with the salicylates has not been encouraging.

The diet is to be suited to the digestive power, and, other things being equal, it is better for the patient to eat as nearly as possible what he is used to. If the appetite is gone, considerable nourishment can be got in in the guise of cold drinks, to which patients always take kindly. Milk, egg-nog, albumin water, and ice cream are usually acceptable, and should be given every four hours if no other food is taken. The temperature not infrequently goes down a degree or more after a meal, and the patient is proportionally more comfortable.

As a rule, patients sleep enough in the course of the twenty-four hours, making up by day-time naps for any wakefulness at night. Trional gr. x to xv acts well in case insomnia is present, and relieves moderate pain.

Local treatment is not effective in most cases, but patients who expect gargles and poultices to the neck should not usually be disappointed. In gargles heat is the main thing. Any hot, non-irritating liquid gives temporary relief, and nothing is better in my experience than milk used as hot as it can be borne and swallowed after gargling. Especially at night such a gargle may give enough relief to enable the patient to get to sleep. The mouth should be rinsed with cold water before and after each feeding—a procedure which makes the meal much more likely to be well borne.

In the pseudo-membranous forms of tonsillitis an effort should be made to prevent the spread of the membrane to the nose, ear, or larynx by the use of a twenty-five volume solution of peroxide of hydrogen as a spray or on a cotton swab.

In the septicæmic cases the treatment is that of any form of septicæmia.

Acute Ulcerative Tonsillitis.

In follicular tonsillitis there is little or no genuine ulceration. Moure[1] has recently reported 9 cases of a very rare affection of the tonsils which he calls by the above title. The general appearance of the disease is very closely similar to that of tertiary tonsillar syphilis. It occurs mostly in young adults. The onset is insidious. There is usually no fever or other constitutional symptoms, pain on swallowing being the chief complaint. Examination of the throat shows on one or both tonsils a considerable loss of substance, punched out, with sharp red edges, and often a cheesy deposit at the bottom. There is no swelling and no involvement of the cervical lymph-glands. There may be two or three such ulcerations on each tonsil, with no tendency to coalesce.

If the exudate covering the floor of the ulcer be removed, we find a granulating surface beneath. It has the appearance of a spot which has been cauterized several days previously. The ulceration may be as large as a dime or even larger; it is always rather deep, and may extend to the floor of the tonsillar space. "The lesion is absolutely benign and ephemeral and runs its course in a few days."

[1] *Centralb. für Laryngologie, etc.*, Feb. 1897.

Diagnosis.—(*a*) *Lupus* of the tonsil is distinguished by its longer course. (*b*) *Chancre* of the tonsil causes swelling of the whole tonsil and cervical adenitis, and lasts often for several weeks. (*c*) *Gumma* of the tonsil bears a very close resemblance to the disease which we are considering, but usually occurs toward the edge of the tonsil and extends rapidly to the pillars of the fauces, the soft palate, pharynx, or tongue, while acute ulcerative tonsillitis does not spread. The infiltrated edges, the chronic course, and the history of syphilis usually suffice to distinguish the gummatous ulcer from ulcerative tonsillitis.

Treatment.—The sloughs should be carefully removed and the following gargle used every four hours:

Boracis,	
Potassii bromidi,	*āā.* ʒj;
Glycerini,	ʒj;
Aquam,	ad ʒviij.

Smoking should be forbidden, and the debility which is often present treated in the ordinary ways.

Suppurative Tonsillitis.

Synonyms: Quinsy; Tonsillar abscess; Peritonsillar abscess; Parenchymatous tonsillitis; Phlegmon of the tonsil.

Although it has been strenuously insisted by Bosworth that all cases start in the peritonsillar tissue and only incidentally perforate the tonsil, the great majority of writers make no such distinction, since they find usually some involvement both of the tonsil and of the tissues which surround it. Clinically, the distinction is not important.

Etiology.—Males between twenty and forty are most frequently attacked, and cases are more numerous in early spring and late autumn than at other times of the year.

The disease seems to occur in certain families with particular frequency, and affects especially the poorer classes. One attack predisposes to another.

Most writers agree in regarding the disease as connected in some way with rheumatism, though MacKenzie attributed but little importance to the admittedly frequent association of the two diseases.

Persons whose tonsils are chronically enlarged are apparently more apt to suffer from quinsy, especially in cases where subacute attacks of superficial inflammation are of frequent occurrence.

Attacks are occasionally preceded by exposure to cold, by one of the exanthemata, or by a follicular form of tonsillitis, the common factor in these predisposing causes being the debility which they all tend to produce, and which renders the patient more susceptible to the action of bacteria and their products.

Probably the micro-organisms active in the disease are those normally present in the gland crypts—namely, the pyogenic cocci and the pneumococcus, whose effects are ordinarily warded off by the action of phagocytes or other protective agencies of the tissues. Owing to a weakening of these protective powers by the predisposing causes of the

disease, inflammation is set up by one or more of the organisms above mentioned.

Pathological Anatomy.—One or both tonsils becomes much enlarged and hyperæmic. In the early stages the organ is hard to the touch, but softens if pus appears.

The throat may be almost occluded by the tumefied tonsils. The salivary and buccal secretions are increased, the cervical glands enlarged, and the jaw may be fixed so that the patient is hardly able to open the mouth.

The uvula and soft palate are displaced by the swollen tonsil and are usually œdematous. The abscess often points midway between the upper edge of the tonsil and the base of the uvula. Sometimes the pus burrows down the side of the pharynx, and may reach as far as the orifice of the œsophagus. Of 133 cases seen by Bosworth,[1] 115 pointed in the soft palate, 11 in the posterior pillar of the fauces, 2 in the tonsil itself, and 2 in the pharynx. Very rarely the pus may make its way down into the tissues of the neck or even into the mediastinum or pleural cavity.

Microscopically, the tissues of the tonsil show hyperæmia and cellular infiltration, as in any other abscess.

Symptoms.—The local discomfort is usually very great and the condition of the patient pitiable.

The pain is generally very severe, and is not confined to the tonsil, but extends to the ear, to the floor of the mouth, and to the angle of the jaw. It is deep-seated, gnawing and boring, or sometimes neuralgic and lancinating. It persists even when the parts are absolutely at rest, but is aggravated by any movement, such as swallowing, speaking, opening the jaws, or even moving the head and neck. The mouth can rarely be opened more than half an inch without great pain.

The salivary secretion is greatly increased and may be fetid, and, owing to the pain and difficulty in swallowing, the patient usually lets the saliva escape from the mouth.

The voice is much altered; it is thick, muffled, and nasal, and articulation causes much pain. Sometimes the Eustachian tube is pressed upon and the patient complains of deafness or noises in the ear.

Nasal breathing is usually obstructed, and smell and taste may be abolished.

"The accumulation of thick and tenacious mucus in the fauces becomes the source of so much annoyance that the patient makes frequent efforts to clear the passages by an attempt at hawking, which is quite characteristic in that the sodden condition of the muscles renders the effort somewhat futile." Torticollis is not infrequent, and contraction of the masseters may be so great as to render examination and treatment difficult.

Constitutional symptoms are also very marked, and the prostration may be early and severe. The temperature is often 104° or 105° F. and the pulse correspondingly elevated. A well-marked chill is often seen at the outset, and chilly sensations are the rule where chill is absent.

Headache, pains in the back and "bones," malaise, and anorexia are

[1] *New York Med. Rec.*, Oct. 4, 1884.

very commonly met with. Constipation is the rule. Sleep is impossible without opiates.

When both tonsils are involved we have an aggravation of all the symptoms, and not infrequently serious disturbance in breathing.

The COURSE of cases if untreated varies a great deal. The exudation may be absorbed and the symptoms disappear within a few days, without there being at any time unmistakable evidence of pus. More commonly fluctuation can be made out in from two to four days, and rupture takes place somewhere between the fifth and tenth day, according to the time of the appearance of pus and the character of the tissues involved. Abscesses which point in the soft palate break sooner than those which extend into the posterior pillar or the wall of the pharynx.

As soon as the pus is evacuated the local and general symptoms rapidly ameliorate, and in a few days the patient is well. The amount of pus discharged is usually small.

If the inflammation has been intense, the process may take a little longer, the pus being discharged intermittently.

Occasionally the burrowing pus opens a bloodvessel. The resulting hemorrhage may be very serious, but is fortunately of rare occurrence. The tonsillar, ascending pharyngeal, or internal carotid are the arteries which may be involved. The majority of the reported cases have terminated fatally. Prompt ligation of the common carotid has saved several recent cases. Burgess reports a case [1] in which, after various hæmostatics had proved useless, the bleeding finally stopped of itself, the patient being greatly exhausted.

DIAGNOSIS.—In the earliest days of the attack diagnosis may be impossible. After twenty-four hours deep fluctuation may often be obtained. The local pain is usually much greater and the swelling more considerable than in other forms of tonsillitis.

Fibrous tumors of the fauces are of very rare occurrence, but may occasionally be mistaken for a quinsy.

PROGNOSIS.—A properly treated tonsillar abscess is almost never a danger to life, but causes a great deal of suffering while it lasts. Cases in which the pus is allowed to burrow and is not evacuated may prove fatal—(*a*) by breaking into the air passages at night; (*b*) by giving rise to a general septicæmia; (*c*) by obstruction of the fauces with or without œdema of the glottis; (*d*) by erosion of a large artery.

Early incision of the abscess will prevent, in practically every case, the occurrence of these complications.

The patient is usually somewhat prostrated by loss of sleep, inability to take food, and by pain, but the course of a well-treated case is seldom over ten days from start to finish.

Attacks are very apt to recur in the spring and fall,—especially in those whose tonsils are chronically enlarged.

TREATMENT.—Sometimes the products of inflammation are absorbed without drainage, natural or artificial. During the earliest stages of the disease an effort should be made to promote absorption by the following measures:

(*a*) Free catharsis by mercurials or salines.

(*b*) Early scarification of the swollen tonsil.

[1] *Lancet*, 1896, p. 105.

(*c*) The use of aconite and of the salicylates (drop doses of the tincture of aconite every hour till the lips and fingers tingle; 10 grains of sodic salicylate every two hours till toxic symptoms appear). The fever may be reduced by phenacetin or lactophenin, gr. v every four hours till the thermometer indicates 100° F. or less.

Local applications, such as ice or cocaine, are usually of little benefit; poultices to the neck are liked by some patients. While waiting for the formation of pus we frequently find the use of morphine indispensable for the control of pain. Bosworth recommends that the patient should rub dry cooking-soda into the tonsil at short intervals.

As soon as the presence of pus is ascertained a curved bistoury should be plunged into the most fluctuant point, and the incision carried from above downward for at least one half an inch, parallel to the anterior pillar of the fauces. The bistoury should be guarded with adhesive plaster up to about three quarters of an inch from the point. If pus does not flow at once, a probe should be inserted and pushed in various directions in search of pus. The flow is often sluggish at best.

After the evacuation of the pus it is important to keep the opening patent until the wound has healed from the bottom, since pus may be penned in by a superficial healing, and in this way an abscess may re-form.

It is often almost impossible for the patient to take food, but he should always be urged to do so, cold liquids and ice-cream being best borne. It may be necessary to cocainize the parts before a meal.

Hypertrophy of the Tonsils (Chronic Tonsillitis).

As a rule, hypertrophy of the faucial tonsils forms part of a general overgrowth of the adenoid tissue of the upper respiratory passages, including the naso-pharynx and pharynx, and in treating of the conditions in the faucial tonsils it is impossible to avoid some repetition of matter covered by the section on the Diseases of the Naso-pharynx.

Etiology.—Occasionally the condition is congenital, and in the great majority of instances we seem forced to assume that congenital influences (of a nature wholly unknown) strongly predispose certain children to an overgrowth of adenoid tissue about the faucial ring. It is essentially a disease of childhood, though it may persist in rare cases into adult life. By some writers it is considered as akin to the scrofulous or tubercular taint, but there is but little evidence to support such a view.

In most cases the tonsils begin to enlarge at about the age of three or four. It is doubtful whether the occurrence of one or more of the exanthemata or of repeated attacks of "sore throat" are to be considered as etiological factors. It is probably truer to consider the recurrent acute attacks as results rather than causes of the hypertrophy.

Bad hygiene does not seem to bear any relation to the disease, which is as frequent in good hygienic conditions as in bad.

Benham has recently reported a case in which chronically enlarged tonsils became very much smaller during an attack of pneumonia, but regained their former size by the end of convalescence.[1]

[1] Benham: *Lancet*, 1896, p. 68.

PATHOLOGICAL ANATOMY.—The lymphoid elements are chiefly involved, without much development of the trabeculæ in most cases. Where the condition persists into adult life the tonsil is firmer, owing to the great hypertrophy of the stroma, but in early life this is usually absent.

The tonsils bulge out in irregular lumps and may almost touch each other. The crypts are always deep, and the closed follicles greatly increased in volume. In the deep crypts masses of mucus, desquamated epithelium, and leucocytes collect and degenerate. Occasionally the tonsil is adherent on one or both sides to the pillars of the fauces, but, as a rule, the tonsil maintains its individuality and is attached only by its base.

There is usually a notable thickening of the lining of the crypts and an enlargement of the bloodvessels.

In the hard tonsils seen in adults occasionally the proliferation of the connective tissue practically obliterates the crypts, and compresses the vessels so that the blood supply is considerably diminished. The surface of such a tonsil is much smoother and somewhat paler than in the common form seen in children.

SYMPTOMS.—Many symptoms once attributed to hypertrophied faucial tonsils are now considered to be due largely or entirely to the encroachment of adenoid growths on the naso-pharynx.

The enlarged faucial tonsils act as foreign bodies and mechanically interfere with the function of the parts if the enlargement is very great, but we are often surprised to see how little trouble they give unless acutely inflamed. Patients breathe, swallow, and talk through a hole that looks very small, without being aware that anything is wrong.

Breathing is sometimes slightly interfered with at night, and the frequent occurrence of nightmare in children with large tonsils may perhaps be thus explained.

The *voice* is altered in cases where the tonsils interfere with the functions of the uvula and soft palate, its tone being sometimes compared to that of a person trying to talk with a full mouth.

Swallowing is rarely interfered with, except during acute inflammations of the enlarged organs.

Mouth-breathing is the rule even when the naso-pharynx is clear. The throat gets dry, and cough may be set up in this way. Stuttering and habit-chorea are said to be dependent on mouth-breathing in certain cases.

Quinlan[1] and others have noted *deafness* due to enlarged faucial tonsils, and cured by their excision. As a rule, this symptom is due to naso-pharyngeal growths, and it is not easy to explain the connection of the faucial tonsil with the ear.

Torticollis is occasionally caused by tonsillar enlargement, and cured by removal of the growths.

It has been already mentioned that in the deep and dilated crypts of hypertrophied tonsils decomposition of secretions and cells goes on. The products of this decomposition are exuded on to the surface of the organs, and over them the air and food ingested must pass. Fetor of the breath is thus brought about. Whether, as Bosworth suggests, the

[1] *New York Eye and Ear Infirmary Reports*, 1896.

general health is impaired by pollution of the air and food in this way may be doubted, since a considerable proportion of children with big tonsils are as well as their neighbors, and such troubles as they *are* subject to can easily be explained in other ways.

Where more serious symptoms, such as mental dulness or misshapen thorax, are present the naso-pharyngeal growths are almost always the chief factor in the trouble.

Children with enlarged tonsils are very liable to "colds," to attacks of tonsillitis, and sometimes to wheezing or "croupy" attacks at night.

Diagnosis.—The faucial tonsils are easily seen if enlarged. When a contraction of the velum palati takes place they approach each other more nearly. The size of the mass to be seen in the mouth depends a good deal on whether or not the tonsils are incarcerated—*i. e.* adherent to the pillars of the pharynx. A free tonsil always looks larger than an incarcerated one, other things being equal. Occasionally they are pedunculated and hang down the throat, so that they may irritate the epiglottis.

Cheesy masses or concretions distending and projecting from the follicles are occasionally seen. They may be imprisoned behind the anterior pillar, and brought to light only by turning the tonsil backward and using a probe.

Malignant disease of the tonsil may develop so insidiously as to suggest only a simple hypertrophy. Such cases are usually unilateral and develop in persons past middle life.

Prognosis.—Enlarged tonsils almost invariably begin to disappear at puberty, and by the twentieth year are gone. This fact, together with the absence of any danger to life, has led some to consider treatment unnecessary. But our prognosis in untreated cases must take account of the fact that before the twentieth year the patient may be permanently injured by the presence of obstructions in the upper air-passages. Further, there is reason to believe that infections may take place more easily through the crypts of enlarged tonsils, and diphtheria occurring in a child with such trouble runs a severer course. The physician's chief concern with the prognosis of hypertrophied tonsils is to change it by his treatment.

Treatment.—Removal of the hypertrophied organ is the essential thing. In the vast majority of cases this is best done with some form of tonsillotome. This instrument does not necessitate the use of an anæsthetic, and does its work with great quickness. It is in principle a guillotine loop, which is fitted around the tonsil and amputates it by a single quick cut. There are various kinds of tonsillotome, each having its advocates, but the general principle is the same.

The patient is held in a sitting position, and if there are any signs of refractiveness the hands should be secured and the mouth prevented from shutting by a gag or pad of towel placed between the teeth. A good light is important.

The instrument is then fitted around the tonsil as near as possible to its base. The spatula which has hitherto held down the tongue is now dropped, and the left hand pressed against the shaft of the tonsillotome, so as to work it into place at the base of the tonsil. A quick contraction of the fingers of the right hand cuts through the tonsil. The

patient's head is then brought forward, so that he can spit out the blood and tissue.

The tonsillotome can be used as a tongue-depressor in refractory cases where the left hand is not at liberty to manage a spatula. The operation is terrifying to children, but not very painful.

If the whole tonsil is not removed by this procedure, what remains may be taken off with the cold wire snare.

With the soft tonsils of childhood, to which the above method is best adapted, hemorrhage is rarely severe. The bleeding, which is at first profuse, usually ceases within half a minute. Almost all the serious hemorrhages reported after tonsillotomy have occurred in adults.

With adults hemorrhage is frequently serious, and not to be controlled by ordinary hæmostatics or styptics,—torsion, pressure, or ligation of the common carotid being usually the only available remedies. Hemorrhage may, however, be avoided in almost all cases by using the cold wire polypus-snare instead of the tonsillotome, and in all adult cases this should be used, especially in hard tonsils where the vessels are too stiff to retract.

In some cases the tonsil has to be dissected out from its bed of adhesions with a bistoury. It is usually best to give an anæsthetic in such cases, since experience shows that without anæsthesia it is hard to get out the whole tonsil, and if any considerable portion is left the trouble may recur.

The throat is not usually much sore twenty-four hours after the operation, but an exudation is sometimes seen on the raw surface, and this may be accompanied by all the symptoms of an ordinary acute tonsillitis. In the membrane seen in such cases the Klebs-Löffler bacillus is sometimes found. Lichtwitz examined 27 such cases, and found the Klebs-Löffler bacillus in 11 cases, twice in pure culture. There were no symptoms to speak of in these cases, and the patients rapidly recovered without antitoxin or other treatment.

Moure states that such complications can be prevented by using washes of lemon juice or boric acid for some days before the operation, and carefully disinfecting the mouth just before operating, and by declining to operate on inflamed tonsils.

Mycosis of the Tonsils.

This may be due (*a*) to the leptothrix buccalis, (*b*) to thrush.

(*a*) **Leptothrix Buccalis.**—Since this organism is present in the mouths of most healthy persons, the question of chief interest is as to the conditions which lead to the deposit of masses of its growth on the tonsils and fauces. The patients are sometimes in the best of health, usually in early adult life. No plausible account of the etiology of the disease has yet been given.

Symptoms.—The disease is a rare one, and gives rise usually to so little disturbance that its existence may be discovered only by accident. No inflammation is excited, and the most that is complained of is feeling of stiffness or a pasty feeling in the throat. There is no fever, and usually no cough.

The fungus develops best in the crypts of the tonsils, and spreads

thence over the surface of the organ about the mouths of the crypts. It may occur on the lingual tonsil, and occasionally is seen on the tongue, soft palate, or pharynx.

Yellowish white, hairy bundles or masses project from the surface, to which they are firmly adherent. Moure states that they have a horny consistency, but in this connection the statement of Kelly,[1] that keratosis is often mistaken for mycosis, should be borne in mind.

The microscopic examination of the masses, which should never be omitted, serves to differentiate the trouble from the cheesy plugs of follicular tonsillitis and from thrush. The absence of all inflammatory change makes tonsillitis impossible.

It may follow or accompany diphtheria, and in case any true membrane is present the cultural test should never be omitted, even when the leptothrix has been demonstrated under the microscope.

The disease, once established, is sometimes obstinate, slowly extending to the adjacent parts and sometimes crossing from one tonsil to the other. Ragged surfaces like those of the lingual and faucial tonsils seem to favor its growth.

The disease is purely local and entirely harmless.

TREATMENT.—The destruction of the fungus *in loco* is the indication. This may be done by the curette or galvano-cautery, or less effectively with chromic acid or silver-nitrate stick. Much patience may be required and recurrences are possible.

(*b*) **Thrush of the tonsil** presents no features differing from thrush of other parts of the mouth (see p. 24). Its occurrence on the tonsils has been lately described by Moumer[2] and by Sendziak.[3] The case described by Sendziak occurred after diphtheria and persisted on the tonsils for two months, having invaded the rest of the mouth for only a fortnight.

DISEASES OF THE LINGUAL TONSIL.

The collection of closed follicles at the base of the tongue, which has recently attracted notice under the name of the lingual tonsil, is subject to most if not all of the diseases by which the faucial and pharyngeal tonsils are affected.

1. Acute Inflammation.

The chief element in a sore throat is sometimes found to be the lingual tonsil. As a rule, the other tonsils are more or less involved, but the appearances, sensations, and results of treatment may point to the lingual tonsil as the principal offender.

SYMPTOMS.—The general symptoms are those already described under Follicular Tonsillitis (p. 35), but the pain is referred to the region of the hyoid bone, and the patient may be conscious of a lump at the base of the tongue, and of pain on swallowing, which is on the middle line and not at the side as in ordinary tonsillitis. The pain sometimes radiates to the ear. Cough is frequent, and aggravates the pain.

[1] *Glasgow Med. Journ.*, Aug.–Oct., 1896. [2] *Gaz. méd. de Nantes*, Oct. 12, 1896.
[3] *Archiv für Laryngol. u. Rhinol.*, 1896, Bd. iv.

Examination shows either simple redness and swelling or discrete yellowish spots, as in follicular inflammation of the faucial tonsil.

Occasionally an abscess forms in or about the lingual tonsil. The tongue is then greatly swollen, and cough or swallowing is exquisitely painful. Œdema of the glottis is a possible complication.

TREATMENT.—Non-suppurative cases are to be treated with local applications of boroglyceride or morphine and tannin. Sodic salicylate is given by many physicians. Abscesses should be opened as soon as the presence of pus is ascertained. Moure reports a case where an abscess of the lingual tonsil ran a very slow course with frequent exacerbations.

2. Hypertrophy.

ETIOLOGY.—The same (mostly unknown) conditions which result in the hypertrophy of adenoid tissue elsewhere in the throat presumably determine hypertrophy in the lingual tonsil. The exception to this statement is the fact that the latter organ is usually affected in adult life rather than in childhood. It is seen more often in females, especially of the neurotic type, perhaps owing to their great proneness to become conscious of relatively slight disturbances.

PATHOLOGY.—Increase in the size of the lymph follicles of the part goes on in a way analogous to that occurring on the other tonsils.

SYMPTOMS.—Considerable increase in the size of the follicles may be present without any symptoms. It is chiefly when the growths touch the epiglottis that they are felt. The patient is rarely able to give us any symptoms more localizing than cough and tickling in the throat, and the diagnosis is made, if at all, in the course of thorough examination of the fauces in search for a cause for the irritation. Occasionally a sense of fulness is experienced in the median line at the base of the tongue.

There is often a tendency to "empty swallowing." Very rarely the epiglottis may be hindered in its motions by the pressure of masses of the growth.

Examination with the laryngeal mirror shows "the glosso-epiglottic fossæ more or less completely filled with a mammillated, somewhat cone-shaped mass of a pale pinkish color."

TREATMENT.—Temporary relief can be obtained by the use of local applications of acetic acid, nitrate of silver, or astringents, but the chief indication is the removal of the hypertrophied follicles. This is best accomplished with the cold wire snare, the use of which is preceded by cocainizing the parts. Soothing lozenges should be used for a day or two after the operation.

DISEASES OF THE UVULA.

1. Œdema of the Uvula.

ETIOLOGY.—Persons whose uvula is broad and pendulous are more susceptible. Attacks are occasionally associated with quinsy or pharyngitis, but most cases occur without involvement of the surrounding

tissues. Caustics and irritants swallowed or applied to the fauces with therapeutic intent are occasional causes.

Symptoms.—Pain on swallowing, the sense of a lump in the throat, and cough are the common symptoms. If the enlargement is very great, we may have dyspnœa.

Examination shows a red swollen uvula whose tip is grayish and semitranslucent from serous infiltration.

Treatment.—Punctures with a sharp bistoury should be made in various parts of the uvula, especially on the lower and posterior portions. These usually give immediate relief. If they do not, the organ may be snipped off.

2. Elongated Uvula.

A congenital condition by reason of which the uvula touches the base of the tongue or the epiglottis.

Instead of the usual three eighths of an inch the organ may be from three fourths to one and a half inches long.

Symptoms.—In some persons there is no discomfort from this condition. In those whose throats are more sensitive it may cause tickling, hawking, and cough. In neurotic patients it may start a spasm of the glottis. The symptoms are worse when the patient lies down.

Treatment.—The organ should be cut down to its normal length—three eighths of an inch. The tip of the uvula is held with a pair of forceps, and the superfluous portion cut off with scissors. Occasionally considerable bleeding follows, but this is chiefly in cases where the whole uvula has been removed, which should never be done. Should hemorrhage occur, the use of hæmostatic forceps followed by ligature will control it.

Soothing lozenges and the avoidance of irritating food for twenty-four hours should be advised.

DISEASES OF THE PHARYNX.

1. Acute Pharyngitis.

The pharynx is practically never acutely diseased except in association with more or less inflammation of the soft palate and tonsils. We shall not consider here the affections of the pharynx which occur in the exanthemata and syphilis, but only the so-called primary pharyngitis.

Etiology.—"*Taking cold*," whatever that means, is undoubtedly the origin of many cases of pharyngitis. It is necessary to add, however, that one may "take cold" from lack of sleep, from confinement in bad air (as in the dissecting-room), and from any form of overwork, as well as from direct exposure to low temperature.

Connection between the diseases of the pharynx and those of the stomach has been insisted on by various writers. French[1] in an investi-

[1] *Trans. of the Amer. Laryng. Assoc.*, May, 1896.

gation of 50 cases of pharyngitis in medical students found a clean tongue in only 1 case, and definite stomach trouble in 47; 14 were constipated. Further, in the study of 23 cases of dyspepsia in women (one half of whom were neurotic) the pharynx were more or less inflamed in every one.

Smoking, alcohol, and highly seasoned food act on the pharynx only when the stomach is also affected. Of the 50 medical students examined by French, the 33 smokers had no worse throat than the 17 non-smokers.

Nasal obstruction is frequently a causal factor. Nasal respiration being cut off, the inspired air is not warmed, moistened, nor disinfected as it is normally in its passage through the nasal cavities.

The extension of a coryza sometimes starts an acute pharyngitis, and the effects of iodide of potash should not be forgotten. Rheumatism and gout are often mentioned as causes, but their influence is doubtful.

Little is known of the bacteriology of acute pharyngitis, but from the constant presence of bacteria in the throat it is natural to suppose that their pathogenic activities are a factor, together with the above predisposing causes.

The disease seems to be sometimes epidemic or endemic, and contagion is often suggested by the occurrence of several cases in a household in rapid succession.

The disease is not more common in infancy, as has been claimed.

Symptoms.—The constitutional symptoms are rarely marked, offering a decided contrast to tonsillitis in this respect. Occasionally there is a degree or two of fever.

There is usually a "scratchy" feeling in the throat and a desire to swallow frequently. There is no pain on swallowing unless the tonsils are involved. The tickling of the throat starts a dry cough, especially on going from a warm to a colder temperature, or *vice versâ*.

The pharynx is reddened and if the naso-pharynx is involved streaks of grayish white secretion are to be seen.

Attacks usually pass off in from three to six days, and do not usually keep the patient from his ordinary occupation. It is to be remembered, however, that a red pharynx is sometimes the first stage of diphtheria or other severe infection.

Treatment.—It is doubtful whether any known treatment affects the course of the disease, but in certain persons the use of lozenges or gargles seems to give relief. Inhalations of steam are grateful in some cases. Gargles should always be given *hot*. The time-honored chlorate of potash is probably as good as any, but no gargle whose taste is unpleasant (*e. g.* listerine) should be used, as it may provoke nausea. Hot milk is a soothing gargle, and used just before going to bed may help the patient to sleep. It is not necessary to keep patients in the house unless fever is present, but the less exertion of mind or body that is made (beyond the needs of ordinary exercise of both) the easier it is to "throw off" the disease.

Where the stomach or the nose is at the bottom of the trouble treatment should be directed chiefly to these organs.

Fever, if present, should be reduced by the use of quinine or phenacetin. The diet should be what the patient is used to, provided no

gastric symptoms are present, and provided his ordinary diet is not obviously bad.

Many mothers expect to have their children's necks poulticed in cases of pharyngitis, and it is not well to disappoint such an expectation.

Chronic Follicular Pharyngitis (Chronic Granular Pharyngitis).

This is a process entirely analogous to the chronic hypertrophy of adenoid tissues elsewhere in the throat.

Etiology.—The disease usually begins in childhood, but does not, as a rule, give rise to symptoms at that time, its manifestations being usually masked by those of the hypertrophied tonsils.

The condition persists into adult life in some cases, and then causes considerable annoyance.

The original cause of the hypertrophy of the pharyngeal lymph follicles is presumably the same as that of the tonsils (see p. 42). It is complained of more frequently by women, but the number of cases is probably the same in both sexes.

There is no reason to suppose that this disease is directly the result of attacks of acute pharyngitis, but the latter often occurs as an exacerbation.

Most writers consider an excessive use of the voice as a causative factor.

Pathological Anatomy.—The mucous membrane is relaxed, the venules are dilated, and roundish bodies from 2 to 4 millimetres in diameter project above the surface. These elevated knobs correspond to the lymph follicles of the pharynx. All the structures of the membrane are more or less thickened, but the chief change is in the follicles.

In childhood the follicles are soft, but as time goes on they get smaller and harder. They may be scattered throughout the pharynx or grouped chiefly about its sides and behind the pillars of the fauces. There is no considerable secretion unless the naso-pharynx is involved. Rarely the follicles contain cheesy plugs.

Symptoms.—*Dull pain* in the throat, especially on speaking or swallowing, is often complained of. *Hoarseness*, which is often complained of, is due to complicating laryngeal troubles. Dry *cough* is the rule. The patient often gets used to these symptoms, and does not mind them, except as they prevent his speaking or singing. *Hawking* is not present unless the naso-pharynx is involved. *Tickling* in the throat leads to a frequent "hem," especially in neurotic individuals, in whom all the symptoms are more marked.

Examination shows in most cases bright red masses about the size of bird shot standing out against the paler tint of the pharyngeal mucous membrane. Rarely the whole pharynx is of the same color, and diagnosis is then more difficult. As before stated, there is no increased secretion, and the uvula is not elongated unless there is a complicating naso-pharyngeal catarrh.

Prognosis.—The disease is chronic and stubborn, but not in any way serious. As years go on the follicles shrink up, but the process is

a very slow one, and patients are usually troubled for years unless the enlarged follicles are removed.

TREATMENT.—The hypertrophied follicles can be removed by actual or galvano-cautery. Several sittings are usually needed, and the throat is decidedly sore after each treatment.

Obvious faults in hygiene should be corrected and the general condition attended to.

PHARYNGITIS SICCA (ATROPHIC PHARYNGITIS).

ETIOLOGY.—Without previous or associated atrophy of the turbinated bodies atrophic pharyngitis rarely if ever occurs. Partly by extension, partly as a result of the desiccation made possible by the cessation of nasal function, the atrophic condition of the pharynx follows that of the nose.

SYMPTOMS.—The patient is usually aware of the dryness of his throat, which is sometimes so great as to make swallowing difficult. Much hawking sometimes takes place in the effort to free the throat from the crusts and scales which form there and cause irritation. Not infrequently the Eustachian tubes are involved and deafness results.

The pharynx and naso-pharynx appear dilated and roomy. The mucous membrane is so dry as to appear as if glazed, with opaque patches here and there. Crusts are often seen similar to those formed in the nose, and there may be deposits of thick greenish secretion. The mucous membrane moves but little, owing to the atrophy of the muscular layer, and is usually very pale.

PROGNOSIS.—To public speakers or singers such a disease is a serious obstacle; it has no tendency to heal, and may resist all treatment.

TREATMENT.—Moure advises vibratory massage applied to the mucous membrane of the nose, naso-pharynx, and pharynx. This, he thinks, tends to favor secretion and awaken the vitality of the mucous membrane. The naso-pharynx should be frequently cleaned, and direct application of menthol 1 : 15 or benzoated glycerin made. General treatment, such as a course of baths at some well-known bath cure, may be of service.

RETROPHARYNGEAL ABSCESSES.

These may be classified as—(*a*) Acute or idiopathic; (*b*) Chronic "cold" or tubercular.

ETIOLOGY.—(*a*) **Idiopathic Form.**—This is by far the most common, making up about 90 per cent. of all cases. It is almost invariably a disease of early infancy. Thus of 77 cases seen by Koplik,[1] 55 were in infants under twelve months, and 65 in those under eighteen months. The children affected are usually in good health. Sex has no influence.

In all probability it is an abscess of pharyngeal lymphatics or lymph follicles in which an infection has become localized, as in quinsy. The atrophy of these follicles in later life explains the rarity of the disease after childhood. It may follow one of the exanthemata

[1] *New York Med. Journal*, April 4, 1896.

or be due to traumatism. Moreau[1] and Koplik[2] think that the infective agent may gain entrance through the tonsil and be carried thence through the lymphatics to lodge in the pharynx. In his cases streptococci were always found, except where the disease was due to vertebral tuberculosis.

Pathological Anatomy.—According to the localization of the infective agent we have naso-pharyngeal, bucco-pharyngeal, latero-pharyngeal, or inferior pharyngeal abscess. The first of these is the more common situation. The presence of the median septum of the pharynx checks the tendency to lateral extension in this direction in most cases, and causes the pus to work up, down, or into the neck, unless it breaks into the mouth. The pus is usually fetid, perhaps from the close relation to the œsophagus. Various organisms have been found other than the streptococcus mentioned by Koplik. Staphylococci, the diplococcus lanceolatus, and the colon bacillus are occasionally cultivated from the abscess.

In children the development of the abscess is usually slow and gradual, as is so frequently the case with abscesses of adenoid tissue. The rare cases which occur in adults develop faster owing to the fact that here the adenoid tissue is largely atrophied and the abscess forms in the cellular tissue, like any other phlegmon.

Symptoms.—When one first hears the cry or cough of an infant suffering from this disease, it is hard to believe it human. It sounds much more like the bark of a puppy or the cry of a large bird ("*cri de canard*," *Reigenier*). The diagnosis can sometimes be made without seeing the patient, simply from the sound of the voice.

The parents are frequently not aware that the throat is the seat of the trouble. Slight fever, cough, and refusal of the breast are noticed, the latter due to the pain or impossibility of swallowing. Later dyspnœa and cyanosis become prominent, the inspiration having sometimes a peculiar crowing quality.

In adults the onset is not so insidious, and attention is at once attracted to the throat. Pain aggravated by swallowing, fever, chills, and later dyspnœa are the prominent symptoms.

Examination.—In children the pus forms so gradually that there is hardly any inflammatory reaction in the surrounding tissues. But, provided our attention is once directed to the pharynx, the presence of a unilateral bulging can usually be made out, which palpation or probing shows to have the consistency of a pus sac.

In adults the tumor is fiery red and very hot to the touch. Occasionally the process may have already extended into the neck when the patient comes under observation.

Diagnosis.—In children retropharyngeal abscess may be mistaken for "croup" or œdema of the glottis; thorough physical examination is the only method of avoiding such an error, since the symptoms may exhibit nothing characteristic. In adults aneurysm and solid tumors are to be excluded.

Prognosis.—In the adult the course is the same as that of a quinsy. In children its duration is from two to four weeks. If not due to vertebral tuberculosis, it is not dangerous to life, provided the diagnosis

[1] *Thèse de Paris*, 1896. [2] *Loc. cit.*

is made in time. But death may result from œdema of the glottis, from direct pressure, suffocation, from erosion of a bloodvessel, from rupture into the trachea or gullet, or from inanition, exhaustion, and septicæmia.

Occasionally death occurs very suddenly and without the presence of any of the above complications. In such cases death may be due to pressure on the great nerves or ganglia of the neck.

TREATMENT.—As soon as the diagnosis is made we should try to evacuate the pus. If no pus has yet formed, scarification may be useful. The lowest point of fluctuation should be opened, and as soon as the pus appears the child should be held head downward to avoid its inhaling the contents of the abscess.

Some writers advise opening the abscess *through the neck* in all cases, but the majority are agreed in reserving this method for cases in which the pus shows no tendency to point in the mouth. Where the pus is burrowing very deeply or very much to one side, or where a contraction of the masseters prevents the jaws from opening, the incision may have to be made through the neck.

In opening an abscess through the mouth the knife should be guarded with adhesive plaster up to within half an inch of the point.

(*b*) **Abscess from Vertebral Caries.**—Here the course is much more chronic, and the pus is apt to burrow along the vertebral column: the symptoms are those of the underlying disease plus a certain amount of pain and bulging in the pharynx. The prognosis is very grave, as the abscess is merely a symptom of a (usually) widespread tuberculosis.

The abscess should not be opened unless the imminence of acute complications or suffocation seems to demand it.

Acute Infectious Phlegmon of the Pharynx.

This rare disease was first described by Senator. Its ETIOLOGY is unknown.

A virulent inflammation starts usually at one side of the pharynx, and rapidly infiltrates the deeper tissues of the neck, with a marked tendency to spread *downward*, so that it may reach the pleura or mediastinum. The neck is much swollen, brawny, and very tender externally, and the lymphatic glands show similar changes. Pain, dyspnœa, and dysphagia are marked.

The COURSE is very rapid, and the general symptoms those of a severe acute septicæmia—high fever, weak, rapid pulse, anorexia, delirium, albuminuria, splenic enlargement, and great prostration. Metastatic processes in the joints and a scarlatiniform eruption may occur.

The DIAGNOSIS rests on the rapid extension of the local signs and the rapid aggravation of the constitutional manifestations.

It is almost invariably a fatal disease, and the TREATMENT must be wholly palliative and symptomatic.

Neuroses of the Pharynx.

1. **Paræsthesiæ.**—Any sensation in the resting pharynx is pathological. In cases of insanity, hysteria, and from "reflex" irritations a great variety of abnormal sensations are referred to the pharynx.

(*a*) *Sensations of Constriction or of a Foreign Body* (*Globus Hystericus*).—This may be due to a spasmodic contraction similar to those which sometimes occur in the œsophagus, but in most cases there is probably no muscular spasm.

(*b*) *Sensations of Heat, Cold, or Irritation in the Absence of Appreciable Cause for Such.*—Of course the diagnosis of a neurosis of this nature is made possible only by the exclusion, through rigid scrutiny of the parts, of all local organic causes for the sensations—*e. g.* enlarged lingual tonsils, distended tonsillar crypts, etc.

2. **Anæsthesia**, partial or complete, and resulting in choking because the parts do not contract at the proper moment.

3. **Hyperæsthesia** with too great or premature contraction, causing dysphagia.

4. **Nervous or functional paralyses**, with trouble in speech or in swallowing.

5. **Spasm.**—(*a*) Choreic; (*b*) Excited by attempts at examination or other causes.

6. **Secretory and Vaso-motor** disturbances: (*a*) Hypersecretion; (*b*) **Urticaria**; (*c*) **Angio-neurotic Œdema.**

The COURSE, PROGNOSIS, and TREATMENT of these affections are those of the neurotic or hysterical disposition underlying them. Local treatment is valuable, if at all, only as a means of suggestion, and the chief aim should be to reform or convert the temperamental condition.

DISEASES OF THE SALIVARY GLANDS.

LEAVING out mumps or epidemic parotitis, an account of which is given under the Infectious Diseases on p. 725 of Vol. I., we have only three affections of the salivary glands:

1. Secondary Parotitis.
2. Ptyalism or Salivation.
3. Xerostomia or Dry Mouth.

1. SECONDARY PAROTITIS (SYMPTOMATIC PAROTITIS; PAROTID BUBO).

If we exclude tuberculosis, mumps, malignant disease, and retention cysts, secondary parotitis is almost the only organic disease of a salivary gland of which we have any knowledge, salivation and dry mouth belonging rather to the functional or secretory disturbances.

The larger number of cases are seen as a complication of *typhoid fever*, but the parotid may be inflamed in the course of typhus, septic diseases, phthisis, pneumonia, and other fevers.

Stephen Paget called attention to the occurrence of parotitis in connection with injuries or diseases of the abdominal or pelvic viscera. Over one half of the 101 cases collected by him occurred in pelvic troubles—sometimes physiological events such as menstruation or pregnancy. Blows on the testis or the insertion of a pessary has been followed by parotitis. Pepper saw a case complicating gastric ulcer.

Fagge observed it in two cases of cancerous obstruction of the intestine, Gowers in peripheral neuritis with facial paralysis.

The connection with genital affections is all the more interesting because of the occasional occurrence of orchitis or epididymitis following mumps. The exact nature of the connection is unknown in both cases.

The cases occurring in the course of infectious diseases may be explained either as metastases taking place by the blood current, or as infection from the mouth by extension up the salivary ducts.

The gland is usually swollen to a greater extent than in mumps, but the affection is usually unilateral. In Paget's cases about 60 per cent. suppurated; the remainder resolved without coming to pus formation. The symptoms are usually overshadowed by those of the underlying disease.

The pus points either behind the ramus of the jaw or burrows into the external auditory meatus or down into the neck or into the pterygoid region.

Osler considers that the occurrence of parotitis in the course of a fever is of unfavorable prognostic significance.

TREATMENT.—An attempt may be made by the use of ice, leeches, iodine, or mercury ointment to favor resolution and prevent pus formation. As soon as pus is known to be present it should be evacuated. A small deep incision and a drainage tube will secure the necessary drainage without the need of a large scar. Flaxseed poultices give great relief.

2. PTYALISM (SALIVATION).

The normal amount of saliva secreted by an adult in the course of twenty-four hours is from two to three pints. Under pathological conditions the quantity may be as much as 5 quarts in twenty-four hours, the saliva being viscid and glairy, and varying in specific gravity from that of water to as high as 1059. It contains but little sulphocyanide of potassium and less ptyalin. This condition is known as ptyalism or salivation.

The condition is now much less common than it used to be, owing to a better understanding of the use of mercury.

ETIOLOGY.—The secretion is somewhat increased by the taking of food and in children by dentition. While these variations are not to be ranked as pathological, it is difficult to draw any distinct line between physiological responses to the stimulation or reflex irritation of food, or teeth, and the varieties of "reflex" salivation next to be enumerated.

We recognize the following varieties:

1. Those cases occurring during a part or the whole of pregnancy.
2. Cases due to drugs, such as pilocarpine, mercury, potassium iodide, jaborandi, muscarine, tobacco; or to metals, such as gold, silver, copper, arsenic, and lead.
3. Cases associated with lesions of the pons and medulla.
4. Cases associated with infective diseases, such as rabies and smallpox.
5. Cases associated with psychic disturbance—insanity, hysteria, the perception of certain tastes.

6. Bohn describes cases in children in which the salivation occurred only in the daytime, ceasing at night; the cause was unknown.

Course and Treatment.—Cases due to mercurial poisoning last often from one to three weeks. The patient gets thin; the bowels are frequently constipated, and the amount of urine small.

In the course of pregnancy, as mentioned above, the trouble may be a very persistent one, ceasing only with the birth of the child.

Effective treatment is ordinarily confined to the treatment of the underlying cause. Astringent solutions—alum, gallic acid—or the tincture of myrrh may be used as mouth washes. The use of atropine, gr. $\frac{1}{60}$ repeated every four hours until the throat becomes dry, sometimes affords relief.

Prophylaxis during the administration of mercurials will prevent the occurrence of many cases. The patient should be directed to brush the teeth several times daily and to rinse the mouth with tincture of myrrh night and morning. Any tenderness of the teeth on striking them smartly together, any soreness of the gums or unusual odor to the breath, should be the signal for withdrawing the mercury until all such symptoms have passed away. Mercurials (*e. g.* calomel) given to a patient with renal disease appear especially prone to cause salivation, so that under such conditions the physician should be as careful as possible in his prophylactic measures.

3. Xerostomia (Dry Mouth).

Jonathan Hutchinson was the first accurately to describe this condition, occurring mostly in neurotic women and characterized by deficient secretion of saliva.

It may come on after a fright or in the course of hysteria or hypochondriasis. Frequently the mode of onset is entirely obscure.

A somewhat similar condition is often seen in diabetes owing to the great loss of water by the kidneys, in mouth-breathers, in aged persons, and in febrile diseases. It is physiological in early infancy.

The mucous membrane of the mouth becomes dry, glazed, and of the color of raw beef. Speaking, swallowing, and chewing are difficult. The tongue may be deeply fissured.

The patient gets temporary relief by moistening the parts with water or oil. Sometimes the use of pilocarpine and more often the galvanic current is of service.

I have seen a diabetic patient who got relief from dryness of the mouth and throat by eating small pieces of oatmeal cracker.

DISEASES OF THE ŒSOPHAGUS.

By ALLEN A. JONES, M. D.

SPASM OF THE ŒSOPHAGUS.

Synonyms.—Œsophagismus; Spasmodic dysphagia; Angina convulsiva; Spasmodic stricture of the œsophagus.

The part played by the œsophagus in the act of swallowing is reflex in nature, its action being similar to intestinal peristalsis. The ganglionic plexuses of the œsophagus are connected with the medulla oblongata by fibres of the vagus, and they also inosculate with the terminal sensory nerve fibres in the mucous membrane. The function of the ganglionic nerves is manifestly motor, while the influence exerted by the vagus is inhibitory, as shown by the fact that section of the pneumogastric causes continuous contraction of the œsophagus.

During the act of swallowing the terminal sensory nerve filaments in the mucous membrane of the œsophagus are stimulated by contact with food, and they convey the stimulus to the ganglionic plexuses, thus producing peristaltic contraction. It is supposed that the medulla oblongata is in a quiescent or non-inhibitory state during the passage of food through the œsophagus, and therefore active peristalsis is allowed. In health the balance between inhibition and action is nicely maintained, but in neuroses spasm of the œsophagus may be caused by reflex irritation from other organs, by lesions involving the roots or branches of the vagus nerve and medulla oblongata, or by psychic influences, as in hysteria.

Etiology.—Spasmodic stenosis of the œsophagus occurs in females more frequently than in males, and particularly in women who are of a neurotic temperament. It occurs in connection with organic diseases of the œsophagus, such as ulceration, and is then called symptomatic spasm. It may be caused reflexly by disease of organs adjacent to the œsophagus, as, for instance, the nose, pharynx, larynx, trachea, heart, lungs, the cervical vertebræ, the stomach and intestines, or by disease of distant organs—the uterus, ovaries, or external genitals. It has been known to result from hypertrophy of lymphoid tissue at the base of the tongue, from chronic follicular tonsillitis, and from accumulation of cerumen in the external auditory meatus. Diseases of the rectum sometimes cause it, and it is occasionally excited by sciatica. It may be the result of toxæmia, as in gout, rheumatism, or uræmia. It is sometimes observed in pregnancy, and is occasionally a symptom of hydrophobia or tetanus. The most important factor in the etiology of the affection is the neurotic condition in neurasthenia, hysteria, or the psychoses. Globus hystericus has been wrongly considered a form of

œsophagismus. There may be temporary spasm associated with globus hystericus, but dysphagia, as a rule, is lacking.

Symptoms.—The cardinal symptoms of this affection are dysphagia, regurgitation, and more or less substernal pain or discomfort. The dysphagia lasts longer in some cases than in others, depending upon the duration of the spasm. The upper part of the œsophagus is a common seat of the contraction, and when so located regurgitation takes place very soon after an attempt at swallowing. If, however, the contraction is lower in the œsophagus, the food is not usually regurgitated until some length of time after being swallowed, the tolerance of the œsophagus above the stricture and its distensibility having much to do with the time allowed before the food is expelled. Complete stenosis of the œsophagus is rarely present, and therefore fluids are swallowed with some degree of ease. Sometimes, however, they are regurgitated, and, strangely, an occasional instance is seen in which solids are swallowed without much difficulty, while fluids are rejected.

The onset of the dysphagia is usually sudden. It may follow a fit of anger, a fright, or some circumstance affecting the nervous system in a forcible manner. Its duration varies in different cases; it may last only a few minutes or for several weeks. The intermittent form of the disease is, however, the more common—spasm occurring at any meal without warning. The dread of its occurrence rather increases the liability to its onset. Some cases have frequent short attacks for many years, while it has been known to occur during the whole lifetime of an individual. Patients troubled with the intermittent form of the affection do not suffer much from lack of food, but those who have many days of continued spasmodic stricture lose weight and strength, and their nutrition may even be very seriously affected.

In many cases the aliment is stayed for a few minutes only, and finally the contraction yields. During its retention at the point of stricture a sensation of severe pain may be felt, or, if not actual pain, a dull, sickening ache precedes the passage of the food through the narrowed portion of the tube. Persistent spasm may result in considerable dilatation of the œsophagus, and food may be regurgitated after remaining some hours or a day in the œsophagus. There is usually a good deal of œsophageal flatus accompanying the regurgitation, and the food returns mixed with ropy mucus.

Symptoms of a spasmodic nature in other organs may accompany œsophagismus, as, for instance, bronchial asthma, hiccough, pharyngeal muscular spasm, while vaso-motor phenomena, cardiac palpitation, or syncope may occur. The affection sometimes ends as suddenly and as unexpectedly as it begins.

Diagnosis.—The affection should be differentiated from organic stricture, benign or malignant, dilatation of the œsophagus, pressure, stenosis of the œsophagus, and impacted foreign bodies. Chief stress is to be laid upon the intermittent character of the spasm, the association of other nervous phenomena, the existence of a sufficient cause for the contraction, the sex and age of the patient, the sudden onset, the fickleness of its behavior, and, in the majority of cases, the well sustained nutrition of the patient. In conjunction with these the passage of the sound is of the greatest utility in diagnosis, as in most cases it passes

beyond the stricture with little or only moderate difficulty, and it glides along into the stomach without the slightest resistance if the patient be anæsthetized. In some cases the passage of a flexible stomach tube is difficult or impossible, but if a stiff bougie is used it may be passed with comparative ease. Organic strictures of large calibre may also admit a stiff bougie, or even allow a stomach tube to pass; so it is necessary to anæsthetize the patient in order to arrive at a more definite conclusion.

In differentiating between œsophagismus and impacted foreign body the Röntgen ray may be of decided value (see "Foreign Bodies," p. 78).

PROGNOSIS.—The prognosis is usually favorable, but should be somewhat guarded if the affection has persisted for a long period or if the patient shows evidence of a greatly disturbed nervous system. As is the case with many of the neuroses, œsophagism may obstinately persist or recur for a long time despite the most thorough management. When the affection is a reflex from serious disease of neighboring parts, the outlook is accordingly discouraging.

TREATMENT.—The cause of the spasm should first be sought for and removed if possible. In case it is not discovered, the condition should be treated by antispasmodics, among the most effectual being asafœtida, valerian, and potassium bromide. Asafœtida should be given in from two to four ounce doses of the emulsion by the rectum, the dose being repeated according to the indications. Sometimes this alone is sufficient to overcome the spasm. If it is not successful, a half drachm or drachm dose of chloral hydrate dissolved in four ounces of camphor water may be given as an enema; this may be repeated if necessary. If liquids are not regurgitated, these remedies may be administered by the mouth. Much value has been ascribed to potassium bromide as a drug that allays the sensibility of the mucous membrane of the pharynx and œsophagus, especially the former, but it must be given in doses of a drachm, or even more, in order to be particularly effectual, and in these doses is very depressing.

In some cases moral treatment alone suffices to effect a cure. Such a case is mentioned by P. Hanshalter of Nancy.[1] The patient was a girl twelve years of age who manifested œsophagism soon after a fit of anger and mortification occasioned by being jeered at by a boy who discovered her while bathing in a river. She was unable to swallow anything save raw carrots and green fruits until the physician announced that at a certain time he would cure her. Preparations were made, the child was suspended for a few minutes by a suspension apparatus, and the physician impressively said that she was cured. She immediately ate and drank a meal that had been brought in while she was suspended, and thereafter was cured.

In this connection much may be accomplished by requiring the patient to eat in the presence of the physician or a stranger, who may make assurances that no harm will befall her from the passage of food into the larynx. Considerable stress has been laid upon the systematic passage of an œsophageal bougie or a stomach tube. If the tube is used, gavage may be practised regularly, and the nutrition of the patient thus maintained.

[1] Quoted in *Sajous' Annual*, 1892.

The passage of the bougie sometimes effects relaxation of the spasm, and it may not be necessary to resort to its further use. The intra-œsophageal application of the continuous current has been employed, and also advised against. The chief objection to its use is that it may cause syncope by its effect upon the pneumogastric, but if used in the strength of from five to fifteen milliampères it will do no harm and may have a good effect. The continuous current may also be applied upon the skin along the tract of the vagus nerves, but should be employed in mild strength. Counter-irritation may be applied along the course of the pneumogastric nerves, or the Paquelin cautery may be used along the cervical and dorsal spine.

In chronic cases hydrotherapy, medical gymnastics, fresh air, change of scene, and all measures for the purpose of restoring tone to the nervous system are called for. Aside from the remedies above mentioned, camphor, sumbul, hyoscyamus, and conium may be used as antispasmodics. Morphine should be resorted to only in extreme cases. As tonics, phosphorus, zinc phosphide or oxide, arsenic, and quinine may be used.

NEUROSES OF THE ŒSOPHAGUS.

Paralysis of the Œsophagus.

Synonyms.—Paralytic dysphagia; Atonic dysphagia.

Etiology.—Paralysis of the œsophagus may be due to (*a*) organic disease of the nerve centres or of the nerves governing motion of the œsophagus; (*b*) functional nerve disturbances; (*c*) diseases of the muscular fibres; (*d*) adhesions.

Dysphagia may result from paralysis of the pharyngeal muscles, whose function is to open the œsophagus. The organic lesions of the nerves or nerve centres that may cause œsophageal paralysis are atrophy of a nerve trunk occurring independently of or following a neuritis; pressure upon the nerve from hemorrhage, or from an abscess or tumor of contiguous parts. Any of these may involve the nerve centre or the nerve trunk. Among the common causes of paralysis in this situation may be classed the toxæmias arising from diphtheria, lead, or syphilis. Functional nerve disturbance may be dependent upon anæmia and malnutrition following fever or other debilitating disease.

Muscular atrophy may result from toxæmia or myositis resulting in connective-tissue proliferation between the muscular fibres. Paralysis that can hardly be called functional is present in dilatation of the œsophagus or adhesions of the organ to neighboring structures. Sometimes it results from a sudden shock to the nervous system, and it may be due to hysteria.

Symptoms.—As paralysis may be local, the symptoms vary with different locations. If it is situated high up at the first part of the œsophagus, food is rejected immediately after an attempt at swallowing is made. In these cases there is some danger of food particles gaining entrance to the larynx, causing suffocation. If the paralysis is acute,

the symptoms are sudden in onset, while if it manifests itself slowly, the symptoms accordingly supervene with some irregularity and delay. If the paralysis is located in the lower part of the œsophagus, a considerable quantity of food may be swallowed and collect above the cardia, being rejected some time after the meal and in large quantities. Patients naturally differ in the tolerance shown to food. Sometimes the dysphagia caused by paralysis is so great that very little food enters the stomach, though it usually passes slowly down the œsophagus, being pushed downward by that which is above. Things may be washed down quite easily sometimes, though usually a considerable period is required before either fluid or solid substances will enter the stomach. There is usually no pain in this affection, unless it be caused by pressure from a large collection of food in the œsophagus.

Pathological Anatomy.—The morbid changes are usually those found in the disease of which œsophageal paralysis is merely one symptom—viz. bulbar paralysis, general paresis, or cerebro-spinal disseminated sclerosis. Occasionally œsophageal paralysis is associated with paralysis of the larynx, soft palate, or tongue.

Diagnosis.—It is important to differentiate between paralysis and stenosis of the œsophagus, and that may be done by auscultation and by the use of the œsophageal sound. When fluids are swallowed the deglutition murmur is heard to be loud and rumbling, so as to be heard sometimes at a distance from the patient; but it is best to use the stethoscope, as the point at which the sound ceases indicates the location at which stasis occurs; this point is usually midway between the upper and lower portions of the œsophagus. The sound enters the stomach without obstruction, the ease with which it passes being sometimes significant. A stiff bougie may be moved freely and widely in the paralyzed area. J. Solis-Cohen speaks of the food as being rejected in the form of an inverted cone, the bolus being subjected to compression only at its upper part. The history of the case and the presence of causative conditions give material aid in the diagnosis.

Prognosis.—The prognosis depends upon the cause. It is necessarily grave if it is due to serious intracranial or spinal cord disease; it is most favorable when dependent upon hysteria. The prognosis should be reserved in some cases until the results of treatment have been observed.

Treatment.—If the disease is caused by syphilitic gumma of the brain or syphilitic peripheral nerve disease, potassium iodide should be given in increasing doses. A good plan is to commence with five minims of a saturated solution of the drug, given in infusion of quassia before meals or with essence of pepsin after meals, the dose being increased one drop a day until thirty or more drops are taken three times a day. If lead-poisoning is present, potassium iodide should be given in ten grain doses three times a day, and magnesium sulphate administered in half ounce or ounce doses in concentrated solution each morning. If necessary, magnesium sulphate may be used as an enema. Nux vomica, ignatia, or strychnine are especially indicated, the advantage of strychnine being that it may be given by the subcutaneous method. In some cases it is necessary to use the stomach tube for feeding purposes, and gavage may be continued as long as it seems indicated.

Duchenne cautioned against the use of electricity in the œsophagus, owing to the danger of over-stimulation of the pneumogastric and resulting fatal syncope. We have, however, seen strong currents of electricity used in the œsophagus without any untoward effects, and the intra-œsophageal application of a gentle faradic current is certainly strongly indicated in paralysis of the organ. It should be used tentatively, and discontinued at once upon the appearance of untoward symptoms. J. Solis-Cohen attaches much importance to Duchenne's caution against the use of electricity, while Fitz advises the use of the continuous and interrupted currents by means of the œsophagal electrode when either of them is indicated.

Hyperæsthesia of the Œsophagus.

Hyperæsthesia of the œsophagus is sometimes present in hysteria, neurasthenia, and hypochondriasis. It is an underlying factor in the causation of œsophageal spasm in some cases, and may be manifested either by special predisposition to such spasm or by unnatural sensations of soreness, burning, prickling, or distress upon swallowing solids or liquids. When symptoms of œsophageal paræsthesia are present, organic diseases such as ulcer or œsophagitis should be eliminated if possible. Œsophagoscopy may materially assist in the diagnosis. Clinically we find cases in which unnatural sensations—a common one being that known as globus hystericus—are referred to the region of the œsophagus, and may be due to hyperæsthesia of that structure.

Zenker and von Ziemssen consider hyperæsthesia of the œsophageal mucous membrane as a particular cause of œsophagismus in many cases, and mention the analogous conditions of over-sensitiveness and spasm of the pharynx and larynx; also the favorable effect of potassium bromide in these affections. As this condition is purely functional, there are no morbid changes to be considered.

Diagnosis.—In many cases, of course, the diagnosis is largely hypothetical, though from a clinical standpoint we are not infrequently justified in concluding that hyperæsthesia is present.

Treatment.—The treatment should be directed toward the correction of the accompanying nervous disorder. Of the drugs that have been found useful in our hands, asafœtida, valerian, camphor, and potassium bromide claim first mention, and of these asafœtida seems the most valuable and reliable. The emulsum asafœtidæ is the form in which the drug seems most effectual. It should be given in large doses, not less than half an ounce, four times a day; its unpleasant odor is not an insurmountable difficulty to its administration in many cases, although it is frequently not prescribed when it should be, purely from that consideration. In a case of hyperæsthesia and irregular mild œsophagismus now under the writer's care asafœtida is very effectual. This is the case of a young woman who is chlorotic and is also taking iron and arsenic.

Anæsthesia of the Œsophagus.

Anæsthesia of the œsophagus may be present in cases of slight dysphagia or sluggish peristalsis of the œsophagus without manifest organic

lesion. Patients not infrequently complain that their food goes down too slowly, and they therefore readily form the habit of washing it down with copious draughts of water, tea, or coffee. In these cases sometimes a highly spiced bolus of food is swallowed with more ease and despatch than a less stimulating bolus. It is possible that anæsthesia of the œsophageal mucous membrane may be an underlying factor in the causation of paralysis in rare cases.

TREATMENT.—When for clinical reasons this condition seems present, the treatment should consist in the use of strychnine or nux vomica with the intra-œsophageal application of the faradic current and appropriate general treatment.

ORGANIC STRICTURE OF THE ŒSOPHAGUS.

SYNONYMS.—Œsophageal stenosis ; Obstruction of the œsophagus.

ETIOLOGY.—Stricture is caused by changes in the wall of the œsophagus interfering with its natural distention or narrowing its lumen. It most commonly results from cicatricial formation during the healing process of a wound, ulcer, or any loss of substance from burns or otherwise, and also from benign or malignant tumors occurring in the œsophageal wall.

Next to carcinoma, the most common cause of stricture of the œsophagus is cicatricial obliteration due to the swallowing of caustic or corrosive fluids, which happens not infrequently either from accident or intention. Sulphuric acid, strong ammonia, carbolic acid, or other caustics may be swallowed. Very frequently, however, death results from the taking of these substances, but sometimes they are taken in insufficient quantity to produce death, yet in sufficient quantity to cause destruction of a portion of the mucous membrane of the œsophagus.

Cicatricial stricture occurs most frequently about on a level with the cricoid cartilage, and next in frequency near the cardiac orifice ; it may, however, be located anywhere along the œsophagus or involve its whole length. The calibre of the stricture varies according to the depth of destruction of the œsophageal wall. If the mucous membrane alone is destroyed, a layer of connective tissue is formed which is tolerably smooth, though it may project into the lumen of the tube at different points. These projections may even have a papillomatous appearance. If the muscular layer is destroyed, a thick, hard cicatrix results, which by progressive contraction more and more diminishes the calibre of the tube, which may indeed be entirely obliterated. It is apparent that, as is the case in stricture of the urethra, its calibre varies between wide limits.

The stricture may be angular in form, new connective tissue proliferation being evenly distributed throughout the whole circumference of the tube, or it may be more dense upon one side than upon the other, as is especially the case in the cicatrix of a small ulcer. This cicatrix may project somewhat into the lumen of the œsophagus. Strictures may be single or multiple ; when multiple their calibre may be of different size.

Besides the destruction of tissue resulting from the swallowing of caustics, ulceration may occur as the result of too hot a bolus of food or sharp bones or other foreign bodies passing into the œsophagus. In rare cases stricture has followed smallpox as the result of cicatrization of the eruption in the œsophagus. Instances have been recorded in which round ulcer of the œsophagus in its cicatrizing stage resulted in stricture. It is thought that round ulcer in this situation is caused by digestion of a localized area of the œsophageal mucous membrane by the gastric juice, a small quantity of which remains in the œsophagus after vomiting. This hypothesis is probably incorrect, as round ulcer in this situation is as likely a result of trophic disturbance as when it is situated in the stomach or duodenum. Syphilis is also a cause of ulcer of the œsophagus, as has been attested by numerous observers, and cicatrization following tubercular ulcer is also a cause of stricture. Benign and malignant tumors involving the mucous membrane and the deeper structures of the wall of the œsophagus, as well as abscess in that situation, usually cause obstruction. Stenosis may also result from pressure of tumors, enlarged organs, or a variety of diseases involving adjacent structures. Enlarged bronchial and cervical glands, such as sometimes occur in Hodgkin's disease, may cause pressure stenosis. An over-distended diverticulum of the œsophagus or an enlarged thyroid may have the same effect. Perhaps only the lateral portions of the thyroid may enlarge, and cause pressure upon the œsophagus without noticeable increase in the size of the gland in its middle. The enlargement of the thyroid may result from simple hyperplasia or from malignant disease. Sometimes abscess in tuberculosis of the vertebræ and tumors and exostoses in this situation, or even extensive lordosis, may be responsible for the disease. Eichhorst mentions that it has been observed as the result of dislocation of the hyoid bone and clavicle, also from excessive length of the styloid process and ossification of the stylo-hyoid ligaments and thickening of the cricoid cartilage. Cancer of the lungs or pleuræ, retraction of the apex of the lung, pericarditis with effusion, hypertrophy of the heart, aneurysm of the aorta, subclavian or carotid arteries, mediastinal tumors or abscess, may be the cause of the condition.

In its etiology must be included the impaction of foreign bodies, a variety of which may be swallowed. Those, however, most liable to remain impacted in the œsophagus are either so large that their passage is an impossibility, or because they are very irregular in shape, with jagged corners and edges, such as a dental plate, or because they are sharp-pointed and therefore liable to lodge in the mucous membrane. Sometimes large pieces of bone lodge in the œsophagus and demand operative procedure for their removal. Finally, stenosis or atresia may be congenital in origin, although but few cases are upon record. Everard Holmes, Cassan, and Zenker have reported cases, and Grandou cites that of a newborn infant that took the nipple an hour after birth, but was noticed to become congested and purple each time it nursed. Upon abandoning the breast it immediately vomited the milk it had taken. Efforts at feeding were ineffectual, and gavage was also a failure. Death occurred on the sixth day, and in front of the trachea the œsophagus was entirely replaced by a firm band or cord an inch long which was adherent in front to the trachea. Beyond this the œsophagus appeared

normal. An opening was found connecting the inferior portion of the œsophagus with the trachea. Stenosis occurs more commonly in males than in females, the benign cicatricial form occurring in the young and middle-aged most frequently, while that caused by malignant disease is observed later in life.

Symptoms.—The symptoms usually manifest themselves slowly, the most important being gradually increasing dysphagia. Difficulty in swallowing solids is first experienced, especially when they are insufficiently masticated or a large bolus is attempted. The stricture may be such that the food passes it slowly, and in that case there is no interference with nutrition until considerable time has elapsed, during which the calibre of the stricture grows smaller. In some cases dysphagia rapidly increases. Compensatory hypertrophy of the muscular layer above the stricture may take place to such a degree that even though its calibre be small all the food may be forced through if sufficient time is allowed. When solid food may no longer be swallowed, semisolid or fluid still passes with some ease. Finally, the stenosis may become so complete that even liquids are regurgitated. With organic stricture more or less spasm is sometimes associated, and periods of pronounced dysphagia alternate with periods of comparatively easy swallowing. This fact is occasionally quite confusing in the diagnosis, organic stenosis not infrequently being mistaken for œsophagismus.

As dilatation of the œsophagus above the stricture usually occurs, many mouthfuls of food may be swallowed, and regurgitation take place only after the œsophagus is more or less distended with food. Pain is an inconstant symptom: in some cases it is present, while in others it is absent. Occasionally it is quite severe, and is usually aggravated by eating, since the pressure, fulness, and distress are almost always present when the food collects above the stricture, and these sensations are relieved after free regurgitation has occurred. The regurgitated contents consist of food mixed with an abundance of tenacious, ropy mucus, the food being merely water-soaked, not digested. The reaction varies with the reaction of the ingesta. If the starches are well masticated, ptyalin digestion continues in the œsophagus. Evidences of the digestion of nitrogenous substances are entirely absent unless predigested foods have been taken. If the stenosis be due to carcinoma, there may be blood or blood cells, or fragments of the neoplasm which upon microscopic examination show the presence of cell nests. The strength and weight of the patient are gradually reduced and anæmia is progressive; the skin is dry and harsh; great thirst is frequently present; finally emaciation becomes extreme and the patient may die of gradual exhaustion. In some cases, however, rupture of the œsophagus may take place, or asphyxia may result from the inhalation of regurgitated material.

If the stenosis be due to malignant disease, ulceration may temporarily enlarge the lumen of the stricture, and swallowing may be for a time successful, to be followed, however, by a recurrence of the dysphagia. If the stricture be due to carcinoma or to pressure upon the œsophagus, dysphonia or aphonia may be caused by interference with the recurrent laryngeal nerve, and dyspnœa may be due to the same cause or to compression of the trachea. On auscultation upon the back

at the left of the spine on a level with the eighth dorsal vertebra, or anteriorly on a level with, and to the left of, the ensiform cartilage, the deglutition murmur may be heard to occur later than seven seconds, the time it usually follows swallowing in health, or in the case of complete stenosis may be altogether absent. A loud gurgling sound is sometimes heard at the seat of the stricture even though there is an absence of a hissing sound, indicating the passage of the liquids into the stomach. In some cases, however, auscultation affords little information.

Diagnosis.—Sometimes the diagnosis is extremely easy, although in some cases it is difficult and is only to be determined by extended observation of the case. The slow onset, the history of syphilis or tuberculosis, or of the swallowing of caustics are significant points. There may be enlargement of the supraclavicular or other lymph nodes, while secondary carcinomata may be discovered, thus suggesting malignant stricture. The age and sex are to be considered; dysphagia, pain, and pressure symptoms are important points. The use of the sound gives most valuable information. A stiff, hollow, fenestrated œsophageal tube or olive-tipped bougie may be used, the latter indicating the location, size, extent, and consistence of the stricture, as well as the number if there be more than one. Caution should be exercised in using the bougie not to injure or rupture the œsophagus, and if there is reason to suspect pressure from an aneurysm, sounds should not be employed at all. Care should also be taken not to introduce the sound into the larynx, an accident which may occur if the stricture is located in the upper part of the œsophagus. Sometimes it is necessary to anæsthetize the patient before passing a sound.

Marie devised a sound with a compressible olive-pointed tip and a manometer upon its proximal extremity. When the sound reached the stenosis the color-fluid in the manometer rose, owing to compression of the tip, and fell again after the obstruction was passed. By this means he measured the length of the stricture, and also obtained some idea as to the variations in the different parts of its calibre.

The stricture may be located by œsophagoscopy, which was first practised by Mikulicz, and has since been employed by Rosenheim and others. The *x*-rays may also prove serviceable in diagnosis, as a neoplasm may give a distinct shadow or the dilated portion of the œsophagus above the stricture may thus be detected if it is filled with bismuth mixture.

Prognosis.—The prognosis is unfavorable in most cases. With benign stenosis the patient may live for years, provided obstruction be not complete, and in these cases surgical treatment may prolong life.

Treatment.—So long as semifluid or liquid foods may be swallowed and thus maintain a fair degree of health and strength, there is no particular occasion for interference with the stricture. As soon, however, as the patient is starving an endeavor to enlarge the calibre of the stricture should be made. This may be done by slow dilatation, using graduated sounds or bougies, while if possible gavage should be employed to ensure nourishment to the patient. Gradual dilatation may be supplemented by electrolysis, which has proved successful in some instances. Continuous dilatation may be practised by leaving the

œsophageal tube in place. Intubation of the œsophagus is a valuable method of treatment in cases in which the stricture is located in its first portion. George W. Gay of Boston considers it superior to gastrostomy. The ordinary length of œsophageal tubes is about eight inches, and they are of different calibres. A tube may be worn for several weeks even in a case of malignant disease. If it is impossible to dilate a stricture either by the rapid or gradual method or to introduce an œsophageal tube, the only remaining measures are surgical. Œsophagostomy, gastrostomy, or œsophagotomy are operations demanded by threatened starvation. Supporting remedies, such as strychnine, quinine, and rectal feeding, should be employed. Finally, morphine should be used when the case is hopeless and our main purpose is to encourage euthanasia.

CARCINOMA OF THE ŒSOPHAGUS.

Etiology.—Carcinoma of the œsophagus is more frequent in males than in females, about three-fourths of the cases occurring in the former. It occurs most commonly between the ages of forty and sixty, although it may be present earlier or later in life. Rebitzer says the average age is fifty-eight years, and Butlin says it occurs upon an average in females ten years younger than in males. It is usually primary, but may be secondary. Zenker and von Ziemssen found in 5079 autopsies primary carcinoma 13 times, or 0.25 per cent., while the secondary form was present in 6 cases, or 0.11 per cent.

Irritation of the œsophagus, whether acute or of long standing, is considered by some to predispose to the development of carcinoma. As carcinoma sometimes has its starting point in a cicatrix of an old gastric ulcer, so it may spring from the seat of an ulcer in the œsophagus. Alcoholism and wounds of the mucous membrane caused by foreign bodies may determine the development of carcinoma. The most common site is in the lower third of the œsophagus, though Mackenzie considers the upper third as the part most frequently involved. It is also located at the point where the œsophagus crosses the left bronchus. These three points—viz. in the vicinity of the cricoid cartilage, opposite the left bronchus, and at the diaphragm—are probably subject to more irritation during swallowing than are other parts of the tube. The cases seen by the writer have been almost all situated in the lower third. It may occur at any point or involve the whole œsophagus.

Carcinoma is the most common disease and the most important neoplasm affecting the œsophagus. The primary form is the squamous epithelium type, similar to that observed so commonly in the lip. It occurs isolated or in widespread infiltrations, the disease beginning in the mucous membrane, extending to the muscular coat, and from thence to adjacent tissues and organs, causing more or less inflammation of these parts. The mucous membrane becomes greatly thickened and its surface is rough and lobulated, projecting into the lumen of the œsophagus. The muscular coat becomes infiltrated and thickened,

which, with proliferation and infiltration of the surrounding tissue, causes rigidity of the œsophagus and diminution of its calibre. Usually there is only one growth, from one to three inches in length, although in some cases it is of much greater extent.

Ulceration of the œsophageal surface readily occurs, and this process leads to perforation into organs that are involved in the cancerous growth, which may extend to the trachea, bronchi, lungs, and pleuræ, or to the heart or aorta, pericardium or peritoneum, pharynx, and stomach. The vertebræ may be involved or the growth may extend into the spinal canal between the vertebræ. The bronchial, tracheal, and mediastinal lymph nodes are commonly secondarily involved, while the cervical lymph nodes usually escape, although the supraclavicular, especially the left, is said to be frequently enlarged in the presence of intrathoracic malignant growths. The disease may spread by dissemination through the lymph channels, or metastasis may take place and thus the liver most frequently, and the lungs next in frequency, may be secondarily diseased.

Petri holds that when the cancer is situated at or near the cardia its elements may be transmitted directly to the liver through the inferior œsophageal veins which empty into the portal. Metastases have been found in the kidneys, suprarenal capsules, pancreas, bones, and brain. Perforation most frequently happens in the trachea, bronchi, and lungs, although it may take place into the pericardium, pleuræ, peritoneum, or mediastinum, or into the heart or great bloodvessels. Ewald described a case in 1895 in which perforation occurred into the aorta in a man sixty years of age, who suddenly developed hematemesis and died. Vimot and others have also reported cases of death from ulcerative perforation of the aorta. The growth may also perforate the carotid, the subclavian, or pulmonary arteries. The pneumogastric nerves or the recurrent laryngeal may be involved in the neoplasm, and thus dysphonia or aphonia arise.

The œsophagus is usually dilated above the growth, at first its musculature being hypertrophied but later thinned and atrophied; below the growth it is collapsed.

Symptoms.—The symptoms usually make themselves manifest slowly. Pain may be present early, or it may be absent throughout the entire course of the disease. Dysphagia is at first experienced only when solid foot is eaten; later semisolid and liquid foods are regurgitated, though a small quantity may pass into the stomach. There is no hard-and-fast rule that applies to all cases in reference to the onset and severity of the symptoms, as these may last in one for nearly two years, while another may succumb in six or eight months. Gradually or steadily increasing dysphagia with regurgitation of part of the food at first, and later of all the ingesta, pain or substernal pressure and distress, thirst, anorexia, loss of weight and strength, either a coated or clean, attenuated, glazed, dry, red tongue, foul breath, persistent constipation, progressive anæmia, weak pulse, nervous phenomena, cachexia, —these and other symptoms are present as the case may be, and are significant of serious trouble.

Involvement of the recurrent laryngeal nerve may cause, besides dysphonia or aphonia, aggravated cough or dyspnœa. If the neoplasm

is situated in the upper part of the œsophagus, it may be visible either with an ordinary laryngoscopic mirror or with the œsophagoscope, or it may be accessible to the finger in this region. If it extends to the pharynx, it may be visible through the mouth. The regurgitated contents may contain fragments of cancer, which readily become detached owing to the ulcerative process, and which usually contain the so-called "pearly" globules or cell nests. In addition to the food, there may also be pus and blood, and usually these are mixed with an abundance of ropy mucus. The regurgitated food may have remained many hours in the œsophagus above the stricture, but is found entirely undigested. It is neutral or slightly acid in reaction, showing especially an absence of hydrochloric acid and an absence of the end products of albuminoid digestion. Starch digestion may occur from continued action of the ptyalin, provided mastication is thorough, though it has been found that the saliva in malignant and wasting diseases is markedly deficient in ptyalin. In only one condition of the stomach is the food returned so wholly undigested as it is from a stenosed, dilated œsophagus. This is the condition termed by Einhorn "achylia gastrica," and described by the writer as "gastric anacidity." Upon careful examination, however, the gastric contents in cases presenting all the clinical manifestations of achylia may reveal traces of pepsin and rennet or the rennet zymogen, which is not the case with the contents of the œsophagus. If predigested food has been taken, due allowance should be made in the examination. The attempt to pass the stomach tube is usually ineffectual, though it may sometimes be pushed through the stricture in cases of total inability to swallow. The growth in these cases is probably soft and villous, with pendulous masses projecting into the lumen of the stricture, and the stomach tube doubtless pushes them aside, whereas upon deglutition they are simply wedged more firmly into the narrowed portion of the œsophagus. Bougies may be passed or stenosis may be sufficiently complete to prevent their entrance. The deglutition murmurs may be greatly delayed beyond the normal six or seven seconds, or they may be absent, depending upon the degree of stenosis. Loud gurgling sounds may be heard above the stricture. According to Gaucher, compression of the recurrent laryngeal nerve may in rare instances cause suffocative attacks early in the disease before dysphagia occurs.

Diagnosis.—Cancer of the œsophagus is not usually suspected until more or less stenosis is manifest. It is chiefly important to differentiate between malignant and benign stenosis. The age and sex of the patient and the history should be taken into account. In cancer pressure symptoms are more common, especially if it is situated at the bifurcation of the trachea or in the vicinity of the cricoid, and cachexia is earlier and more marked than in benign stricture. If the disease be advanced, the examination of the blood may show a grave anæmia, with a moderate leucocytosis in the event of ulceration of the neoplasm. Glandular enlargement, especially the supraclavicular, with the discovery of carcinoma in other regions, will serve as valuable diagnostic points. If fragments of cancer are found in the regurgitated matter, the diagnosis will be confirmed.

Prognosis.—The prognosis is extremely unfavorable. In a patient

not too far advanced in years who still has considerable reserve vitality life may be prolonged and made tolerable by gastrostomy or by œsophageal intubation. Symonds of London uses a tube about six inches long made of gum elastic and woven silk. It tapers from a small lower end to a funnel-shaped upper extremity. The lower end has an eye through which liquid food escapes into the stomach. A silk cord is attached to the upper end of the tube and is drawn out through the mouth. The tube is inserted by means of a whalebone rod.

Strictures usually dilate under this treatment, and the tube may remain in position without being removed for several weeks, though it is frequently necessary to remove it for cleansing purposes. With a tube in place swallowing is sometimes possible until shortly before death, and life is prolonged because the element of starvation is obviated. S. J. Mixter of Boston has used this treatment satisfactorily in several cases, and considers it very valuable, and Solis-Cohen also endorses it. Intubation is manifestly applicable to both malignant and benign strictures of the œsophagus, and it is to be recommended because in some cases after withdrawal of the tube swallowing may be performed with comparative ease for a considerable period. In some instances it is impossible to introduce the tube from above, it being then necessary to perform gastrotomy and insert the tube from the stomach.

Moravitsky treated a case of carcinoma of the œsophagus with carmine in daily doses of ten grains for a period of five months. Improvement occurred, but finally the carmine lost its effect, and pyoktanin in solution was substituted with very satisfactory results. One case, however, does not necessarily prove the value of these remedies. Sometimes the patient may be nourished by gavage when the dysphagia is so marked that starvation is imminent. Nutritive enemata should be resorted to when insufficient food is taken into the stomach. Bracing and tonic remedies, especially strychnine, should be used in suitable doses to assist in maintaining the strength of the patient. General hygienic management should of course be carried out in the best possible way in each case. If necessary, gastrostomy should be performed with a view of prolonging life.

Other Tumors of the Œsophagus.—Sarcoma of the œsophagus is a rare affection. It has been found in the very young, and is more liable to occur before the age of forty than is carcinoma. Lympho-sarcoma of the œsopahgus has been found at the age of four years. Benign tumors, fibromata, myomata, myxomata, lipomata, lymphomata, and cysts, all of which are extremely rare, occur in the œsophagus. Sometimes fibromata appear as polypi having long pendulous attachments. Cases of polypi have been recorded in which occlusion of the œsophagus resulted. Sometimes adenoma is found, and may have a polypoid appearance. The symptoms of sarcoma are much the same as those of carcinoma, while the clinical history of benign tumors of the œsophagus is usually that of more or less occlusion of the tube. Small myxomata may exist without causing much obstruction, and the same is true of small retention cysts.

DILATATION OF THE ŒSOPHAGUS.

ETIOLOGY.—Dilatation of the œsophagus may be diffuse (cylindrical) or sacculated (diverticulum). Only a small portion of the organ may be dilated, or the whole tube may be enlarged in all directions or in a fusiform manner. Dilatation has been found commencing at the cricoid cartilage and ending at, or a few centimetres above, the cardia. Sometimes dilatation is so great that the diameter of the œsophagus is four or more inches, and its capacity accordingly increased. The organ is also lengthened, and in rare cases it has been found almost twice its normal length and tortuous in shape. The disease is classed as primary and secondary.

Primary dilatation is in rare instances a congenital affection, owing to an insufficient muscular coat, but occurring in later life it is said to result from injury to the chest, from the ingestion of large amounts of liquid, and from chronic catarrhal œsophagitis, in which affection the mucous membrane of the œsophagus may be nodular or ulcerated. Fatty degeneration of the muscular coat and chronic interstitial inflammation of the deeper coats have been found. The affection is one of early life, giving rise to dysphagia and regurgitation. Patients may or may not be conscious of the lodgement of food in the œsophagus, but usually a sense of distress, fulness, or pain is felt when sufficient food has been ingested to cause pressure. Food may be washed down with large quantities of liquid, and various positions of the body may be assumed to assist deglutition ; a sense of suffocation and palpitation sometimes results from the pressure of a large collection of food distending the œsophagus. Such a collection may remain many hours before being regurgitated, and while in the œsophagus may undergo fermentation or putrefaction, causing extremely foul breath. When regurgitated the food is entirely undigested with the exception of a change that starches may have undergone from the action of ptyalin. The disease may last many years, and, though recovery may occur, the prognosis is doubtful. It may be necessary to feed by means of the stomach tube for a protracted period.

Secondary dilatation of the œsophagus results from obstruction somewhere along the course of the organ. Such obstruction may result from impaction of a foreign body, from cicatricial or malignant stenosis, the presence of an occluding benign tumor, syphilitic gumma, or pressure from without. Carcinoma and cicatricial stenosis are the most common causes of secondary dilatation. The muscular coat of the œsophagus above the constriction at first hypertrophies, but later grows thin, its fibres stretch and atrophy, and as dilatation progresses peristaltic power gradually diminishes until it is entirely abolished. Below the obstruction the œsophagus is collapsed. The mucous membrane above the stricture is in a condition of chronic catarrhal inflammation, and as the inflammatory process extends to the deeper structures the wall is often considerably thickened—a condition not inconsistent with extreme dilatation.

The SYMPTOMS of this affection are those of stenosis of the œsophagus coupled with the symptoms peculiar to its cause.

The PROGNOSIS necessarily depends upon the cause. If dilatation results from malignant disease, the outlook is hopeless; whereas, on the other hand, if a benign tumor or impacted foreign body is removable, the prognosis is favorable.

TREATMENT.—If this disease can be diagnosed, early feeding should be practised through the stomach tube quite persistently, though a small quantity should be masticated and swallowed by the patient. The object of this is to prevent or delay stenosis by the frequent passage of the stomach tube, which will maintain the calibre of the œsophagus, and also to prevent an accumulation of food in the dilating portion. The small quantity of easily deglutible food eaten by the patient is amply sufficient to give the muscular layer of the œsophageal wall enough labor to prevent its atrophy. As dilatation is almost always secondary to obstruction, the most effectual treatment consists in its removal when possible; if it is not practicable, the œsophagus should be intubated or gastrostomy should be performed. The ingesta should be most nutritious, and strychnine should be given in large doses.

DIVERTICULUM OF THE ŒSOPHAGUS.

DEFINITION.—A circumscribed saccular dilatation or pouch of the œsophagus.

Two forms—(1) the pulsion (pressure) and (2) the traction diverticula—are described.

1. **Pulsion Diverticulum.**—ETIOLOGY.—Congenital defects, such as misplacement of the vitelline duct or a faulty development of the bronchial clefts, have been thought possible causes. It is, however, rarely found in the newborn or in the young, but is a disease of advanced life, the fortieth year or later. It is more common in men than in women, and almost always occurs at the junction of the pharynx with the œsophagus. It occurs at the posterior part of the œsophagus in the median line or only slightly to one side of it, a situation in which the muscular coat is weakest and the lumen narrowest. In most cases the diverticulum has no muscular layer, though in some instances a few muscular fibres may be seen, and the condition consists of a protrusion of the mucous membrane between the separated muscular fibres, thus resembling a hernia. Zenker and von Ziemssen state that the initial cause of the weakening of the œsophagus is, in the majority of cases, the lodgement of a foreign body which presses upon and separates the muscular fibres, between which the mucous membrane is forced gradually farther and farther by repeated acts of swallowing. A small foreign body like a kernel of corn if lodged a few days and then rejected is sufficient to start the trouble. The muscular layer may also be weakened by ulceration or trauma.

PATHOLOGICAL ANATOMY.—The diverticulum is always single, arises from the posterior and upper portion of the œsophagus, and is usually pear-shaped. It may be very small or several inches (four to six) in length. It presses upon the œsophagus, pushing it forward and

making it difficult for food or a sound to pass into the stomach. The mucous membrane of the pouch is in a condition of chronic catarrhal inflammation.

Symptoms.—In some cases symptoms are absent for many years, but usually dysphagia is pronounced and persistent, growing progressively worse. The sac fills with food and may appear as a tumor in the neck. Manipulation sometimes empties it and the swelling disappears. The pouch when full may press upon the œsophagus below and cause complete pressure stenosis, and if large enough the diverticulum may, by pressure upon the heart, trachea, bronchi, or recurrent laryngeal nerve, cause palpitation, dyspnœa, or suffocation. The food is usually not regurgitated until several hours have elapsed after its ingestion, unless at any meal the pouch becomes over-distended. If the diverticulum interferes seriously with nutrition, the patient manifests symptoms of inanition, and finally dies from exhaustion if no complication carries him off. There will manifestly be added to the local symptoms those of a depraved general nutrition and starvation.

Diagnosis.—In place of the normal deglutition murmur there may be heard gurgling, rumbling sounds in the diverticulum when fluid is swallowed. If an attempt is made to pass the stomach tube, it usually enters the pouch and its contents may be withdrawn. After it is empty a sound may be left in it, while one or two extra sounds may be passed successfully into the œsophagus. Emptying the diverticulum sometimes gives relief, and food more easily enters the stomach. The tip of the sound may be felt at the bottom of the diverticulum. The *x*-rays may prove useful by photographing a diverticulum distended with bismuth mixture.

Prognosis.—The disease may last for many years notwithstanding marked dysphagia. Patients learn by many little manipulations to swallow sufficient food upon which to subsist, though it is often necessary to perform gastrostomy and nourish by that means. Walter Whitehead in 1882 performed gastrostomy upon a woman who had suffered from dysphagia for eight years. She was nourished by the gastric fistula, and then again commenced to swallow her food, but gradually failed and died a few years later. A diverticulum three inches in depth was found.

Treatment.—From a medical standpoint tonics and careful conservation of the vital forces are indicated. Brilliant results have been achieved by surgeons in the removal of diverticula. Kocher of Berne reported two cases of successful removal and complete cure. Von Bergmann successfully removed a diverticulum of probable congenital origin in the case of a woman aged thirty-eight years. In some cases a stomach tube may be introduced without much difficulty and the patient nourished by gavage. Intubation of the œsophagus as practised by Butlin and Mixter for stricture should be tried if the diverticulum is not too high up.

2. **Traction Diverticulum.**—Traction diverticula are caused by adhesions forming between the œsophagus and neighboring bronchial or tracheal lymph nodes, or inflammatory processes in the mediastinum may result in adhesions. As the adhesions retract the wall of the œsophagus is drawn outward, and funnel-shaped depressions from one half to three

quarters of an inch in depth are formed in the œsophagus. The periadenitis is commonly the result of tubercular disease extending from the lung, though it may depend upon inhalation lobular pneumonia or caries of the sternum, vertebræ, or ribs. Traction may also result from pleurisy or pericarditis.

Symptoms.—There is usually no interference with deglutition, owing to the small size of the diverticulum. Perforation is the chief danger, and it may be caused by retained food giving rise to ulceration into a bronchus, thus exciting pulmonary gangrene or grave pneumonia. Pleuritis, pericarditis, suppurative or gangrenous mediastinitis may also result from perforation.

ACUTE ŒSOPHAGITIS.

Definition.—Acute inflammation of the œsophagus.

Etiology.—Œsophagitis is a rare disease; at least, it is very infrequently recognized clinically. Mild catarrhal œsophagitis occurs as an idiopathic affection from exposure to cold and damp. Frequent use of very hot and very cold drinks is said to cause it, and alcohol, tobacco, and highly irritating spices, such as mustard, sometimes excite it. Irritating drugs also induce it, especially if they are retained in the œsophagus for a length of time owing, let us say, to temporary spasmodic stricture of the organ. Œsophagitis may occur secondarily by extension of the inflammation from the stomach or pharynx. It may arise in the course of the eruptive fevers or be caused by peri-œsophageal inflammation.

The most common causes are the swallowing of corrosive substances and injuries from foreign bodies, which frequently excite phlegmonous œsophagitis—a condition that is also due to spinal caries, abscess of the mediastinum, suppuration of tracheal and bronchial lymph nodes, and smallpox.

Pathological Anatomy.—The inflammatory process may be general or localized, occurring most frequently in the lower portion of the œsophagus. In the catarrhal form there are desquamation of the epithelium and swelling of the mucous follicles, which are filled with mucus or muco-purulent material and appear as small gray elevations. Ulceration may occur in small or large areas, and by extension into the deeper structures cause suppuration and sloughing of portions of the mucous membrane, or an intramural abscess may develop. Gangrene sometimes occurs. The eruption of variola upon the mucous membrane of the œsophagus assumes the form of pustular inflammation; the pustules may, as in the skin, be discrete or confluent.

Phlegmonous œsophagitis, according to the findings of Zenker and von Ziemssen, begins as a submucous purulent infiltration which finally destroys all the constituents of the areolar tissue, and later may rupture through the mucous membrane and cause destruction of extensive areas. Cicatrization following destructive processes of this nature may eventually narrow the lumen of the œsophagus or even cause marked stenosis. Hemorrhage sometimes results from ulcerative processes.

Symptoms.—The chief symptom is painful deglutition, which may last a few days or many weeks. In a case of the writer's the pain

caused by swallowing was accompanied by intense burning in the œsophagus, which lasted several hours after the ingestion of food. The burning pain was so distressing that the patient was rapidly losing weight and strength when she presented herself for treatment, owing to the fact that she subsisted upon a very small amount of semisolid and fluid food. Regurgitation of the food sometimes occurs before it reaches the stomach. In the purulent forms of the disease there is an elevated temperature, with, perhaps, slight or quite pronounced chills. Blood, pus, mucus, or shreds of tissue may be regurgitated in cases with suppurative or gangrenous processes. Thirst is often a prominent symptom.

Diagnosis.—It is sometimes very difficult to differentiate between the milder and severer grades of the affection, but the diagnosis of œsophagitis may be made from the chief symptoms—deglutition pain and regurgitation, with, perhaps, spasm of the muscular fibres of the œsophagus. Inspection of the pharynx in a second case of the writer's showed marked follicular pharyngitis, and it is not improbable that the œsophagitis was closely related to the pharyngitis. By means of the œsophagoscope inflammatory processes of different varieties might be detected, but the instrument is not in general use. The passage of the sound meets with no obstruction unless tumefaction be very great or the swelling of an abscess encroaches upon the lumen of the gullet. Other diseases of the œsophagus should be differentiated if possible.

Prognosis.—The outlook in the catarrhal form is favorable, but in the suppurative varieties the prognosis is grave, owing to the liability of perforation, gangrene, or subsequent stricture.

Treatment.—Fluid diet should be insisted upon until all acute symptoms subside. Sometimes even liquids are regurgitated, and then nutritive enemata should be given. If it is possible to ascertain the cause, it should receive attention. In case the œsophagus is burned by very hot ingesta, cracked ice may be sucked, and sodium bicarbonate should be placed dry upon the tongue and swallowed slowly. Soda gives distinct relief if used in this manner, a few grains being allowed at a time. Bismuth subnitrate suspended in mucilage of tragacanth is another soothing and healing remedy, or the dry bismuth may be placed upon the tongue and swallowed without water, in order that it may spread over the œsophageal mucous membrane.

If burning pain is intense, relief may be afforded by adding a quarter or a half grain of cocaine muriate to the soda or bismuth. In case of phlegmonous inflammation rest in bed should be ordered, supporting measures adopted, anodyne and mild antiseptic emollient solutions administered, and surgical measures instituted if perforation occurs. As recovery takes place solid food ought not to be allowed too early.

CHRONIC ŒSOPHAGITIS.

Etiology.—Repeated attacks of acute or subacute œsophagitis may lead to chronic inflammation. It is apt to result from the constant use of very hot and irritating drinks. Abuse of alcohol is said to induce it.

Passive congestion of the œsophagus, as in chronic pulmonary and cardiac affections, is likely to cause it. Sometimes chronic œsophagitis succeeds the injury caused by a foreign body which remains lodged in the œsophagus for a considerable length of time, or it may be set up by extension of inflammatory processes in contiguous structures. It accompanies carcinoma, benign stenosis, tubercular and syphilitic lesions.

Pathological Anatomy.—Klebs and Zenker and von Ziemssen insist that inflammations of the mucosa of the œsophagus differ very materially from inflammations of the mucous membrane of the stomach. There is rarely found abundant mucus, such as occurs in the stomach. Proliferation of connective tissue leads to thickening of the mucous membrane—even, in rare instances, causing polypoid growths. The muscularis sometimes becomes hypertrophied, and when this is associated with marked hyperplasia of the submucous tissues the lumen of the œsophagus may be encroached upon, and if it is situated near the cardia stenosis and dilatation may follow.

Symptoms.—Chronic œsophagitis may exist without causing symptoms, though sensations of deep substernal soreness and rawness may not infrequently be complained of. The passage of the food, especially rough ingesta, may cause a sense of soreness, or actual dysphagia may be present at times. It is likely that the inflammation undergoes repeated exacerbations, and that the symptoms are then more marked, but subside again as soon as the temporary increased congestion passes away. There may be symptoms of stenosis added to those above mentioned.

Diagnosis.—The diagnosis is necessarily presumptive in some cases; in others the symptoms are sufficiently pronounced and definite to afford diagnostic data. Œsophagoscopy might detect the true state of affairs.

Prognosis.—The prognosis is favorable in mild forms of catarrhal œsophagitis, and it assumes gravity only in cases with deeper inflammatory involvement causing stricture.

Treatment.—The cause should be treated if it is possible to ascertain it. The diet should be bland and non-irritating. Alcohol should be interdicted, excepting it be taken highly diluted, and then only when it is indicated from a medical standpoint. When burning follows the ingestion of food it may be greatly relieved by the administration of small quantities of bismuth, with a drop or two of chloroform, suspended in mucilage of tragacanth. A favorite formula of the writer's is as follows:

℞. Bismuthi subnitratis, ʒij;
Chloroformi, gtt. xx;
Mucilaginis tragacanthidis,
Aquæ menthæ piperitæ, āā. q. s. ad ℥iv.
Sig. Teaspoonful undiluted as often as needed to relieve burning.

This prescription answers well in the acute form of œsophagitis. Astringents should be applied to the mucous membrane of the œsophagus by means of a soft sponge or absorbent cotton securely attached to an applicator. Argentic nitrate is the best, and should be used in the strength of eight grains to the ounce. Argonin, alum, tannin, hydras-

tis, iron, or other astringent may be employed. The stomach tube or œsophageal sound should be passed occasionally in order to prevent the formation of a stricture.

MEMBRANOUS ŒSOPHAGITIS.

True croupous membranes are sometimes formed in the œsophagus. They are usually found in patches scattered over the mucous membrane, especially in the upper portion of the organ, but they may occur in longitudinal strips or spread over a considerable area. Several instances of exfoliation of the epithelial layer of the œsophagus have been reported. Birch-Hirschfeld, Reichmann, Fitz, Rosenberg, and others have contributed illustrative cases of great interest. Reichmann's case was that of a man thirty-three years old who had sudden occlusion of the œsophagus, vomited a thick membrane a few days afterward, and later passed a similar formation per rectum. The membrane was a cast of the œsophagus, and was composed of a number of layers of squamous epithelium. This, then, is different from either a fibrinous or mucous cast, which latter so commonly occurs in so-called membranous colitis. Fibrinous œsophagitis may be caused by extension of the disease from the pharynx. It occurs sometimes in pulmonary tuberculosis, typhoid fever, the exanthematous fevers, pyæmia, nephritis, and pneumonia. Ulceration and hemorrhage occasionally happen at the site of these croupous deposits. The writer recently saw a case with Dr. J. C. Brown of Southport, Pa., in which the mucous membrane, submucous tissues, and part of the muscular layer of the œsophagus, together with the mucous membrane of the cardia and a portion of the stomach, were vomited as a complete cast ten days after the swallowing of a corrosive.

FOREIGN BODIES IN THE ŒSOPHAGUS.

Foreign bodies frequently lodge in the œsophagus. They are often swallowed by accident, though they are commonly intentionally swallowed, especially by the insane. They may be classed into those that are smooth and regular in shape and lodge only because of their large size; those that are rough and jagged, and very liable to catch in the mucous membrane; and, finally, those that are sharp-pointed and likely to penetrate the wall of the œsophagus. This, of course, is merely a suggestive classification. Among the foreign bodies most frequently lodged in the œsophagus are coins, dental plates, pins, needles, and fishbones. The insane not infrequently swallow a great variety of sharp articles, such as stones, tacks, nails, hairpins, screws, and occasionally knives, forks, and spoons. Jackstones and toothbrushes have been found in the œsophagus. Large pieces of beef, mutton, or chicken bones are sometimes accidentally swallowed.

Foreign bodies may be ejected by the patient or pass down into the stomach, where they may remain or move onward and be expelled per rectum. Gould and Pyle in their interesting book, *Anomalies and Curiosities of Medicine*, cite Evans' case of a girl who swallowed a gold plate with four artificial teeth, and two years afterward vomited them after violent retching. Another case is cited in the same work, of a young man who swallowed a coin that lodged and remained in the middle portion of the œsophagus for ten months, causing great pain. It then passed into the stomach, and after thirty-five years had not been passed by the rectum. It will thus be seen that bodies may remain for a protracted period in the œsophagus or stomach without causing death. On the other hand, the gravest results often follow their retention in the œsophagus. In the first place, obstruction results, and may even prevent the passage of liquids into the stomach; therefore strength and weight are soon lost. More serious still is the likelihood of perforation into the trachea, bronchus, lungs, pleura, mediastinum, or large vessels. Fatal pneumonia, pulmonary abscess, or gangrene may thus result or empyema may be caused. Sudden fatal hemorrhage has resulted from perforation into the aorta. Gould and Pyle mention that Poulet collected 31 cases of perforation into the neighboring bloodvessels; into the aorta, 17; carotids, 4; vena cava, 2; inferior thyroid artery, right coronary vein, demi-azygos vein, right subclavicular (abnormal) artery, and the œsophageal artery, each 1. Cases of perforation into the innominate artery are also recorded. In many cases of perforation into the bloodvessels the foreign body is either a sharp-pointed bone or something that easily penetrates the tissues. Sharp foreign bodies frequently migrate through the tissues and appear beneath the skin at some remote portion of the trunk or extremities. Needles and pins have been found, years after they were swallowed, in the side between the ribs, in the neck, behind the ear, in the abdominal parietes, and elsewhere. The literature contains many interesting reports of such cases. The results of migration may or may not be harmless. Foreign bodies have recently been photographed in the œsophagus by the *x*-rays with marked success, being thus definitely located.

Treatment.—American and foreign surgeons agree that foreign bodies should not be allowed to remain impacted any longer than can be avoided, owing to the danger of ulceration, abscess formation, and serious results. Certain medical means may be tried before surgical methods are resorted to. The patient should drink a glass of milk, and be given an emetic forty minutes thereafter. The milk goes down in a fluid state, forms large curds in the stomach, which when vomited carry a small body, such as a fishbone, before them. Successful removal of some foreign bodies may be accomplished by directing the patient to swallow a tangled mass of thread, which is left in the œsophagus for some time and then withdrawn, with perhaps, the article in its meshes. Fishbones and coins have been removed in this manner. It is proper to push the body gently toward the stomach in case it is known to be smooth and unlikely to lacerate the œsophagus, but if gentle efforts do not succeed in moving it, no force should be applied.

An attempt should be made to extract the foreign body with forceps, especially if it is lodged in the upper part of the œsophagus. Von

Haeker[1] reports a case in which he removed a fragment of bone by the aid of electric light; the œsophagoscope guided him in locating the bone and removing its jagged corners, so that it was easily extracted with forceps. The writer has seen a coin successfully removed from the upper part of the œsophagus by holding the patient, a boy, head downward and vigorously slapping the back between the shoulders. The boy ran excitedly down stairs to his father, who was a physician, and after a few slaps the coin dropped out. Had more than a few seconds elapsed, probably the treatment would have failed.

Œsophagotomy, gastrotomy, or gastrostomy should be resorted to early, as the gravity of the case increases with the length of time a foreign body remains impacted.

(For further discussion upon these operations the reader is referred to many valuable surgical reports and to works on surgery.)

PERFORATION AND RUPTURE OF THE ŒSOPHAGUS.

Rupture of the œsophagus is an accident that is liable to occur in dilatation, diverticulum, ulceration from an impacted foreign body, abscess in the wall of the œsophagus or in the periœsophageal tissues, and from injury. Sometimes it occurs spontaneously without apparent cause, and the condition described as œsophagomalacia has been found in such cases. It is a rare condition, the majority of cases occurring in men, some of whom habitually use alcohol to excess. Rupture may occur from over-distention of the œsophagus, especially when it is dilated, and when a diverticulum ruptures it is usually owing to ulceration, with, perhaps, over-distention from a collection of food or gas in the sac. It sometimes happens upon great exertion or a violent jar, as over-straining in lifting or jumping, or falling from a considerable height. Morley[2] reports the case of a middle-aged German who was seized with pain in the stomach and hematemesis upon jumping from his wagon. He was an alcoholic and died on the second day. On post-mortem a linear rupture of the œsophagus was found at its cardiac extremity. G. R. Turner[3] mentions the case of an apparently healthy woman in which rupture of the œsophagus occurred from vomiting, the patient dying within twenty-four hours. At autopsy a left-sided pneumo-thorax was found with collapse of the lung.

Rupture is also apt to occur from the action of corrosive substances upon the wall of the œsophagus, and quite frequently it is caused by carcinomatous ulceration; indeed, any morbid process leading to more or less solution of continuity in the wall or marked thinning and weakening of the wall may lead to rupture.

Zenker and von Ziemssen classify rupture of the œsophagus as primary and secondary—primary occurring from diseases of the œsophagus itself, and the secondary occurring from diseases of the bronchial and tracheal lymph nodes, caries of the vertebræ, ulceration of the trachea,

[1] *Wiener klin. Woch.*, Oct. 31, 1889. [2] *Northwestern Lancet*, April 1, 1892.
[3] *London Med. Soc.*, Jan. 11, 1897.

abscess or gangrene of the lung, aneurysm of the aorta, empyema, and mediastinal abscess.

Perforation may occur in any part of the œsophagus, but is more frequent in the intra-thoracic than in the cervical portion, the anterior wall near the bifurcation of the trachea being a favorite point. The size of the perforation varies greatly according to the underlying disease and the violence causing it; the opening may be only large enough to admit a small probe or it may be one inch or more in diameter. Linear perforations usually result from peri-œsophageal disease.

Symptoms.—The immediate symptoms of rupture are sudden great pain felt beneath the shoulder-blades or beneath the sternum, with symptoms of shock. The temperature in some cases is elevated; in others it is subnormal; nausea and vomiting frequently occur, occasionally hematemesis being immediate and copious; and bloody stools may be observed. If rupture occurs into the pleural cavity, there may be signs of pleural effusion or pneumo-thorax, as pyo-pneumo-thorax is quickly developed. If it occurs into the pericardium, pyo-pneumo-pericardium results; if into one of the bronchi, symptoms of purulent tracheitis, bronchitis, lobular pneumonia, pulmonary abscess, or gangrene may quickly manifest themselves; if into the aorta, sudden fatal hemorrhage follows; if into the mediastinum, abscess or gangrene occurs.

Sometimes protective adhesions are formed about the œsophagus, and perforation may burrow along through these adhesions and appear in the neck, giving rise to subcutaneous emphysema—a condition which, however, occurs in rupture without peri-œsophageal adhesions.

Diagnosis.—The diagnosis is sometimes extremely difficult, while in some cases it is made with comparative ease.

Prognosis.—The prognosis is extremely grave, death usually occurring immediately or in a few days.

Treatment.—The medical treatment is symptomatic, stimulants and morphine being indicated. No food or liquid of any kind should be allowed by the mouth, but nutritive enemata should be employed. In some cases surgical measures promptly resorted to might perhaps save or prolong life.

ULCER OF THE ŒSOPHAGUS.

Ulcer of the œsophagus occurs sometimes in acute œsophagitis, especially when the inflammation is caused by chemical irritants, and also in chronic œsophagitis of the follicular type. It may occur in smallpox as a local manifestation of the disease. Foreign bodies injuring the mucosa frequently lead to ulceration. It may be tubercular or syphilitic, and is a frequent accompaniment of malignant disease of the œsophagus. Involvement of the œsophageal mucous membrane from suppurative processes in adjacent parts may also cause it.

Peptic ulcer of the œsophagus is occasionally seen. Guitéras[1] reports the case of a woman, aged forty-four, in whom numerous ulcers were

[1] *Int. Med. Magazine*, Nov., 1894.

found post-mortem. Most of these ulcers were small, varying in size from a pinhead to a pea, while opposite the bifurcation of the trachea two large perforating ulcers were found. Microscopic examination showed anæmia of the tissues, absence of extensive areas of involvement, and the presence of large numbers of plasma cells in the layers of the œsophagus. The edges of one ulcer showed little evidence of inflammatory reaction; the muscular coat showed no evidence of degeneration. Guitéras concludes from a study of the case that "the absence of hyperplasias, of thickening, of congestion, and of the clean-cut edges of the more recent ulcers would exclude the view that they were the result of catarrhal inflammation." The ulcers had the anatomical features of peptic ulcers, and Guitéras considered them due to hysterical ischæmia and the habit of merycismus which was practised by the patient.

Dr. Herbert U. Williams of Buffalo has kindly furnished the writer with a report of a case of œsophageal ulcer, probably peptic, upon which he performed the autopsy. The case was that of a well-formed male child, three days old, who had suffered from profuse hemorrhages from the rectum, and it was remarked that the blood had the appearance of being arterial. There was also vomiting of blood. Further clinical history could not be obtained. The autopsy was made twenty-four hours after death. The case was supposed to be one of hæmophilia. Examination of the mucous and serous surfaces of the skin showed no petechiæ; in fact, there were no hemorrhages except that from the alimentary tract, and all the organs appeared normal, except that there were uric acid infarcts of the kidneys. The umbilicus and the umbilical vein appeared normal; they were examined with reference to possible infection; for the same reason the liver was examined for bacteria by attempts at cultures and by smear preparations with negative results. The stomach and intestines were filled with dark blood clots. The only lesion found in the alimentary tract was a shallow ulcer in the posterior wall of the œsophagus just above the stomach. It was oval in shape, one-half to seven-eighths of an inch long; no bacteria could be discovered in sections of this ulcer. In the centre it passed down to the muscular coat; over the greater part of it the mucosa and muscularis mucosa were wanting; the adjacent tissues were infiltrated with blood.

The causation of peptic ulcer of the œsophagus is probably the same as that of peptic ulcer of the stomach and duodenum. Anæmia of a localized area of mucous membrane is not sufficient reason for its occurrence. It is probably the result of a tropho-neurosis resembling herpes in this respect.

HEMORRHAGE OF THE ŒSOPHAGUS.

Hemorrhage is more likely to occur in advanced age. In some cases of cirrhosis of the liver and thrombosis of the portal vein a varicose condition of the veins of the œsophagus is present; and profuse, sometimes fatal, hemorrhage not infrequently happens. Small and

repeated hemorrhages may, however, occur in any stage of cirrhosis, sometimes being the earliest manifestations of the disease. When hemorrhage is caused by rupture of varicose veins, the blood is usually regurgitated, not vomited. Profuse and rapidly fatal hemorrhage follows the rupture of an aneurysm into the œsophagus or a perforation of the œsophagus into the aorta or other large vessels. Hemorrhages of different degrees may also occur from erosion or ulceration of the œsophageal mucous membrane. Rupture and perforation are sometimes accompanied by profuse hemorrhage from the wall of the œsophagus. It occurs also in carcinoma and from the presence of sharp foreign bodies.

TUBERCULOSIS OF THE ŒSOPHAGUS.

Tubercular lesions rarely occur in the œsophagus. They may result from extension of the disease from the bronchial lymph nodes, the larynx, vertebræ, or pharynx. Pepper and Edsall reported a case of "tuberculous occlusion of the œsophagus, with partial cancerous infiltration,"[1] in which probably a local tuberculosis of the œsophagus occurred, and cancer arose from the chronic irritation. Such cases are very rare.

SYPHILIS OF THE ŒSOPHAGUS.

Syphilitic lesions of the œsophagus may result from extension of ulcerative processes in the pharynx. Ulceration or gummata may be found. Syphilitic ulcers not infrequently cause cicatricial stenosis of the œsophagus, and indicate the use of iodide of potassium in large and continued dosage.

PARASITIC DISEASE OF THE ŒSOPHAGUS.

Vegetable parasites rarely lodge upon the œsophageal mucous membrane. Thrush (*synonyms:* Oïdium albicans; Sprue; Œsophagomycosis oïdica) may extend from the mouth to the œsophagus, occurring most commonly in children, being associated sometimes with measles, scarlet fever, smallpox, and pulmonary tuberculosis. Zenker and von Ziemssen found it in adults most frequently in connection with phthisis and typhus fever; it occurs also in pyæmia and puerperal fever.

Oïdium albicans may appear as small or large patches on the mucous membrane. Occasionally the fungus proliferates so exuberantly that it causes obstruction. Eichhorst mentions that Wagner noticed that the

[1] *American Journal of the Medical Sciences*, July, 1897.

fungus penetrates the layers of epithelium and causes atrophy of the cells. It may also enter the mucosa and bloodvessels. Sometimes the disease gives rise to no symptoms, though dysphagia or aphagia may be present.

A peculiar complication of sprue of the œsophagus was found by Zenker to be metastasis of the disease in the brain. The fungus spores may be conveyed to the brain by the bloodvessels and develop in the brain substance, as thrush does not occur in the circulation.

The TREATMENT consists in swabbing the œsophagus frequently with a soft sponge or cotton saturated with a solution of borax. If obstruction occurs, it should be overcome by bougies, sounds, or a stiff stomach tube.

Of animal parasites, the only one that invades the œsophagus is the trichina, which may be found in great numbers in the muscular coat of the œsophagus, and may thereby cause dysphagia and perhaps some pain.

CONGENITAL DEFECTS AND MALFORMATIONS.

AMONG the congenital defects of the œsophagus tracheo-œsophageal fistula deserves mention. Pulsion diverticula are sometimes congenital in origin; occasionally cysts of congenital origin are found near or attached to the œsophagus.

According to the suggestion of Fitz, some fault in the development of Meckel's diverticulum may account for duplication pulsion diverticulum and cysts of the œsophagus. The most common abnormality is atresia of the œsophagus, a condition in which it ends in a pouch a short distance below the glottis. From this point, down as far as the bifurcation of the trachea, there exists a fibrous cord in which a few muscular fibres are sometimes found; then the lower portion of the œsophagus is attached to the posterior wall of the trachea.

DISEASES OF THE STOMACH.

By CHARLES G. STOCKTON, M. D., and ALLEN A. JONES, M. D.

GENERAL EXAMINATION OF THE PATIENT, INCLUDING EXAMINATION OF THE STOMACH.

Examination of the Patient.

The application of modern methods to the study of diseases of the stomach is yet too recent for us to expect a perfect agreement as to the pathology of these affections. Some misconceptions may be explained by the tendency that has existed of referring the symptoms of so-called dyspepsia to definite lesions of the gastric mucosa. Of course the stomach, like other organs, is liable to morbid anatomical changes as the result of well-known diseases, but such changes are present less frequently than is commonly supposed, and when loss of substance actually occurs there is no part of the economy in which repair goes on so rapidly as in the gastric mucous membrane. The frequency with which symptoms are referred to the stomach rests upon the remarkable sympathy that exists between that organ and other parts of the economy. In the majority of cases in which complaint is made of the stomach it is not that organ which is at fault, but rather it is the man who is sick and the stomach is merely sounding the alarm. The close relationship existing between gastric symptoms and diseased states of other parts of the body makes it important for a thorough general examination to be made before concluding that there is present a gastric disease. The physical examination of the stomach and the chemical examination of its contents should be left until the last.

The family history is occasionally of importance, as in the instance of cancer or neurotic tendencies, but it is usually necessary to study carefully the patient's personal history. This should include an investigation of his past and present occupation, his habits as to exercising, sleeping, eating, drinking, and smoking, variations in weight, and previous or accompanying illnesses.

As to occupation, it may be learned that the patient was used to active out-of-door life, and experienced trouble with digestion only after taking up a sedentary, in-door occupation, or it may be found that a man having soft muscles and a weak heart suffered from stomach trouble after abruptly resorting to vigorous exercise either in athletics or in labor. There are some special avocations that often give rise to digestive disorders; such, for instance, are those that require a stooping posture with pressure upon the epigastrium, or overtaxing the eyes, or exposure to the influence of lead or other poisons.

As to habits, it should be ascertained if there is a just proportion in the hours spent in exercise, sleep, and recreation. The meals may be too close together, too far apart, or violent exercise may be undertaken without sufficient rest after eating; too much liquid may be taken with meals, or digestion may be disturbed by too much coffee, tea, or alcohol. Certain individuals uniformly suffer from indigestion when using tobacco in any form. Acute febrile diseases, syphilis, gout, influenza, etc. often leave the digestive apparatus in a state of depression, and when anæmia, jaundice, uræmia, and toxæmias of various kinds are present, a disordered digestion is to be expected.

In studying the present condition of the patient attention should be given to his bearing and attitude. The preoccupied and dejected manner observed in those suffering from continued gastric flatulency, the restless, discomposed behavior, the stooped posture and half-surprised expression often seen in the victims of gastralgia, the emaciated, weak, and cachectic appearance frequently accompanying chronic food stagnation, are good examples. A sallow, earthy-colored skin, showing improper secretion; a dry, harsh skin with too rapid loss of epithelium, showing poor nutrition; a skin showing œdema, poor capillary circulation, lividity, or acne; certain forms of eczema, excess of pigment, or syphilides,—may afford important information as to the digestion, inasmuch as some of these may be the results, and others accompaniments, of gastric disturbance. Any of the obstructive diseases of the lungs, as emphysema, interstitial pneumonia, or pulmonary conditions from which blood changes might result—as, for instance, tuberculosis and certain forms of bronchitis—must be considered. The patient's method of breathing, whether abdominal or thoracic, whether hurried or retarded, his ability to expand the chest, and the strength of the respiratory muscles, should be noted. The heart is frequently disturbed from sympathy with functional disorders of the stomach, as is shown by intermittency or great frequency of the pulse. The question of blood pressure is important, and should be studied with relation to the vigor of the heart and the vascular tension. Frequently digestion is disturbed from low blood pressure arising from a feeble heart, when no apparent structural disease of that organ can be discovered. A common cause of functional and structural disease of the stomach is found in the venous stasis resulting from chronic valvular disease of the heart or from pulmonary or hepatic obstruction.

In examination of the kidneys it is not enough to exclude the various forms of nephritis, but the amount and character of urinary solids excreted in twenty-four hours should be ascertained, so that the functional activity of the kidneys may be known. Inquiry should be made as to the presence of renal insufficiency, hyperlithuria, indicanuria, phosphaturia, cystinuria, glycosuria, peptonuria, albuminuria, and the microscopic revelations. An alkaline state of the urine is expected after a full meal, but such alkalinity does not occur in the absence of the secretion of HCl. Nothnagel holds that this is so uniformly true that it may be considered a criterion of the presence of such secretion. Alkalinity following meals is therefore rarely seen in cases of carcinoma ventriculi. The chlorides are diminished when the amount of food taken is small, and a corresponding diminution of urea is also observed.

Laudenheimer found the chlorides diminished in carcinoma without a proportionate decrease in the elimination of urea. Rommelaere showed that the urea is greatly diminished in cases of carcinoma—an observation that has been abundantly confirmed. This fact seems grounded upon the lowered nutrition present in malignant disease, and is known to obtain in other cachectic states. Nothnagel calls attention to the fact that while both chlorides and urea are diminished in benign diseases of the stomach in which nutrition is greatly lowered, the chlorides are disproportionately low in cancer of the stomach. Indicanuria is a common condition when putrefactive changes are present in the intestinal contents—a state of affairs favored by faulty gastric digestion. Simon states that indicanuria is almost constantly present when free HCl is absent from the gastric contents. While this is true in a proportion of cases, the exceptions are so numerous, as we have many times demonstrated, that the rule is rendered worthless.

Functional and organic disease of the liver should be considered in connection with the condition of the intestinal tube. Many cases of gastric disease have their inception in cæcal or other forms of intestinal stasis, sometimes arising from functional inactivity, but often from compression or narrowing of the intestine from displacement of the duodenum, the cæcum, the hepatic or sigmoid flexures, or the transverse section of the colon. A dilated or otherwise weakened descending colon or rectum, an ulcerated, catarrhal, hemorrhoidal, or fissured rectum, may result in intestinal stasis or may disturb the stomach from reflex irritation.

The dejections must be studied as to their frequency, regularity, quantity, and character. With some individuals insufficiency in evacuations exists unknown to themselves, for the reason that there are daily stools, although the amount is too small, and fæcal accumulation results. A moderate accumulation is sufficient to excite hepatic and gastric disorders, particularly in those patients having disturbed secretions, and consequently putrefactive changes in the intestinal tract.

Diarrhœa may be an important symptom of gastric disease, and arises from too rapid peristalsis, disturbed secretion, or offensive fermentation. It may also afford evidence of intestinal catarrh or ulceration that often bear a relation to the gastric disorders. The color, form, and consistency of the stools should be noted, and they should be examined as to the presence of undigested foods. When there is an absence of diarrhœa, and when pancreatic disease can be excluded, the presence of undigested shreds of muscle-fibre and fragments of starchy food may be set down as depending upon faulty gastric digestion. A lienteric diarrhœa following meals generally has its origin in a gastro-intestinal neurosis. Clay-colored or very dark stools, melæna, and stools very offensive in odor should attract attention.

The blood should be examined if there is evidence of anæmia. This condition frequently exists without a proportionate pallor of the mucous membranes, and its presence is suggested more by the quality of the pulse and the condition of the skin than by the color of the lips and gums. While anæmia is frequently a result, it is also often the cause, of digestive failure. For this reason the blood should be studied, not alone to determine the presence or absence of chlorosis nor to enumerate

the red blood cells, but the number of white blood cells should be ascertained, and the variety of both red and white corpuscles should be carefully studied in every case in which a diagnosis is doubtful. (See Vol. II. pp. 639–643.) Inflammatory conditions may thus be differentiated from neuroses, and sometimes the causes of cachectic states may be ascertained.

In malignant disease marked changes in the blood are common, although these changes are inconspicuous in the beginning of the affection. After the appearance of the cachexia the quality of the blood depreciates as to its specific gravity, hæmaglobin, and the number and shape of the cells. In advanced carcinoma there is found a severe secondary anæmia, marked poikilocytosis, and a multinuclear leucocytosis, all of which changes may be observed in other cachectic conditions. Nothnagel in commenting on this work draws attention to the fact that the deterioration of the blood depends largely upon the motor activity of the stomach, and in any case in which the anæmia has been very marked, improvement in general health following gastro-enterostomy, is accompanied by a corresponding improvement in the blood state; which goes to prove that the changes in the blood are not changes special to carcinoma, but are rather the result of interference with assimilation.

Pohl observed that there was a physiological leucocytosis accompanying digestion, and Schneyer found in 18 cases of carcinoma of the stomach that this physiological leucocytosis disappeared, while in all cases of ulcer examined, save one, this transient leucocytosis occurred, although a condition of marasmus was present. It might be expected that the alkalinity of the blood would be increased in cases of gastric anacidity, but, according to the limited investigations of Noorden in this direction, only an inappreciable difference in the alkalinity of the blood was observed in the cases of anacidity and hyperacidity.

It is well known that functional gastric disorders are often due to classified disturbances or diseases of the nervous system; structural disease of the stomach may have the same origin. In neurasthenia comfortable digestion is rarely present, and the condition called "brain-fag" and another known as "brain-irritation" have, quite uniformly, their attending disordered gastric states. Reflex irritation is so commonly the source of functional disturbance of the stomach that certain regions in which the reflexes usually arise—for instance, the genito-urinary apparatus—should receive careful scrutiny. We are indebted to Gould for recognizing and studying the effects of eye-strain upon the digestive organs, and can testify as to the frequency with which this is an etiologic factor in stomach diseases.

The Physical Examination of the Stomach.

We now have many resources for making a physical examination of the stomach. The abdomen should be inspected, with the patient placed first in the upright and then in the horizontal position. Meteorism and peristaltic movements of the stomach and intestine should be looked for, the importance of which was pointed out by Kussmaul, and the contour of the abdomen, including the comparison

of the two sides, should be noted. Palpation of the abdomen while the muscles of the part are thoroughly relaxed, not only over the stomach, but over the other abdominal viscera, should be practised. Chapowsky recommends that palpation be made with the patient in a full warm bath, and hence with muscles more completely relaxed; then by the skilful use of the hand the physician may describe the lower border of the liver, sometimes including the gall-bladder, the spleen, the stomach, the large and small intestines, the appendix, and not infrequently the kidneys.

The gastric succussion or splashing sounds are developed by two methods, the digital and total. The former is practised by requiring the patient to thoroughly relax the abdomen, and then rapidly tapping upon the part with the finger-tips over a line from the umbilicus upward and outward to the border of the left ribs. The latter method is practised by making sudden pressure alternately, first over the region occupied by the fundus of the stomach, and then over the neighborhood of the umbilicus, using both hands. Or the patient may succeed in developing the splashing sound by abruptly relaxing and contracting the abdominal muscles. For its successful demonstration there must be retained in the stomach a certain amount of gas and fluid. For this reason the appearance of the sign after long fasting is particularly significant of food stagnation.

Following palpation, percussion should be made as a means of confirming the impression already gained, and also of determining the amount of gas and fluid in the stomach and intestine, besides discovering the presence of accumulations of fæcal matter, abdominal growths, displacements or enlargements of organs, or the accumulation of fluid within the peritoneal cavity. To locate the upper border of the stomach the percussion should be made from above downward; to locate the lower border, from below upward or from the left flank toward the stomach area. When these procedures are unsatisfactory assistance may be had by distending the stomach with air by means of a rubber bulb connected to the stomach tube, or by causing the patient to drink a solution containing thirty grains of sodium bicarbonate, followed immediately by fifteen grains of tartaric acid in solution. The procedure may be repeated until a proper degree of gastric distention is obtained. As a further assistance the transverse colon may be distended with water as suggested by Simon. Or when the stomach contains considerable fluid, the colon may be distended with gas generated by the method above described (von Ziemssen), or by allowing gas to escape into the rectum through a tube connected with an inverted Seltzer bottle. Auscultation may be successfully employed either alone or conjointly with palpation, or percussion may be made while the stethoscope is placed below the free border of the ribs on a line with the left nipple. The deglutition murmurs can be heard, and, as a rule, the lower border of the stomach can be located by requesting the patient to suddenly retract and then expand the abdominal parietes, thereby producing splashing sounds which are quite audible to the unaided ear, and which enable one to locate the boundaries of the stomach quite accurately by stethoscopy, provided there is enough fluid and gas within the stomach.

The size of the organ is sometimes sought by estimating the quantity of the fluid withdrawn through the tube when the stomach has previously been filled. This measure is not free from dangers, and is in other ways unsatisfactory. Another plan is to introduce a delicate rubber bag attached to the end of a stomach tube. The bag is then inflated with air as much as possible without causing discomfort to the patient; the capacity of the stomach is ascertained by estimating the amount of fluid that the air displaces when it is made to escape into a properly arranged flask. The size, shape, and position of the stomach may be learned by the use of Einhorn's gastro-diaphane, and the same instrument may be useful in detecting deformities of the stomach and growths in the anterior gastric wall. Turck of Chicago has invented an instrument, the gyromele, consisting of a metallic flexible sound having attached to its distal extremity a bulb or sponge. As the sound revolves in its sheath the moving extremity can be felt through the abdominal wall, and thus the lower border of the stomach may be determined. The inventor claims that the bacteria of the stomach may be studied by examining the material that adheres to the sponge. The rubber bag, contrived by Schreiber, already referred to, may be connected with a manometer, as practised by Purgecz, and thus not only the capacity of, but the pressure within, the stomach, and, to some extent, the motions of the stomach, may be studied.

The Stomach Tube.—The most common instrument employed in the diagnosis of stomach diseases is the soft rubber stomach tube of Faucher, an improvement on the rigid tube used by Leube. Ordinarily, in adult patients it should be about five feet long and about half an inch in diameter. There should be two oblong openings, about half an inch in length, at the distal extremity, the first being one half inch, and the second one and a quarter inches, from the rounded end. The calibre of the tube should be as large as possible compatible with proper rigidity. When too flexible there is difficulty in introducing it, and it is also likely to collapse either by pressure or suction during the process of aspiration. When it is too rigid there is danger of injuring the soft parts unless used with caution. When of proper rigidity a stomach tube of the size described will support without bending twelve inches of its own weight if held in the erect position. Such tubes are sometimes divided, for convenience in cleansing or in storage, into two equal parts, and they may be connected when used by glass tubing or a suitable steel clamp. The braided silk tubes are too rigid for most purposes. Larger tubes are rarely necessary if a proper test meal is employed. When called upon to empty a stomach in emergency cases it is best to have a tube with the largest calibre possible. In order to empty the stomach satisfactorily it is found necessary to introduce the tube twenty-two inches beyond the teeth. In short individuals twenty inches may suffice; in the very tall twenty-four inches may be required. In persons of medium stature, if more than twenty-two inches is necessary to remove the gastric contents, it may be assumed that in proportion to the increased length of the tube the stomach is displaced or enlarged. We have found that in a person five feet and ten inches in height the light of the gastro-diaphane appears below the border of the ribs at a point just to the right of the left nipple line when introduced

twenty-two inches from the teeth. Such proficiency is acquired in the use of the stomach tube that other instruments are generally unnecessary for the estimation of the size of the stomach. Ebstein first showed that the stomach tube was equally useful in the very young. For infants under one year of age a No. 12 soft rubber catheter should be selected for purposes of aspiration of the stomach, and should be passed from six to eight inches beyond the lips. Where there exists narrowing in the œsophagus or at the cardia conically shaped tubes or conically shaped sounds of various sizes may be employed. The whalebone sound, to the extremity of which one of the various sized oblong bulbs is attached, may be employed in place of the rubber instrument. The double-current tube, although still in use, is now practically obsolete. It is sometimes employed in connection with Schreiber's rubber bag.

Many rules have been given for introducing the stomach tube, but those most expert in its use will not be able to make the practice unobjectionable to the patient; nevertheless, it is most unusual to find a patient who cannot be made to take the tube without serious difficulty. The patient should sit in a rather high straight-backed chair. A rubber cloth should be thrown on the lap and a rather heavy towel pinned around the neck to protect the clothing. It is best to avoid explanations or discussions. Require the patient to protrude the tongue, and then, having dipped the tube in cold water, slip it back dextrously against the posterior pharyngeal wall, and then steadily and rather quickly push it onward until it has passed the sphincter-like contraction of the œsophagus in the region of the cricoid cartilage. Do not allow the patient to elevate the chin, but if a somewhat violent choking ensues, sternly command him to draw a long breath, and meantime complete the introduction of the tube to the desired point. The tube may be held a little to one side, thus avoiding some of the epiglottic irritation. The patient should steady the tube by holding it, the hand resting against the chin. He should be told not to swallow the saliva, but allow it to drip from the lips.

If the patient becomes excited, calmness may be restored by requiring him to take deep and regular inspirations and to concentrate his mind upon breathing. The stomach contents may now be removed readily by the so-called expression method of Ewald, provided the proper test meal has been taken. The pressure is brought to bear upon the stomach by contraction of the abdominal walls, as in coughing or straining as if at stool. If the contents fail to flow out through the tube, it may be concluded either that the stomach is empty or that the tube has been too far or not far enough introduced. If too far, by bending upward the openings into the tube are raised above the level of the stomach contents. Having procured the undiluted specimen for examination, lavage of the stomach should be practised, as information may be gained by noting the number of flushings required before the water comes away clear as when introduced. The amount and character of the mucus present should be carefully observed. From one to three pints of water should be allowed to flow in at a time, and as it siphons out an estimate should be made of the quantity that returns, so that no unexpected accumulation, hence no improper gastric distention, shall occur.

Having emptied the stomach, the patient should be required to turn his head to one side; the tube should be carried a little to the opposite side and withdrawn by one steady sweep of the arm. When but a small quantity of the stomach contents is required for examination, and when the employment of the stomach tube is not feasible, Einhorn's stomach bucket may be used. This instrument consists of a hollow perforated oval body the size of a cherry, to which a cord is attached. The bucket is swallowed by the patient, the deglutition made easier by drinking a little water. Having remained in the stomach for a short period, the bucket is withdrawn by means of the cord, the patient at the same time being instructed to swallow.

Examination of the Stomach Contents.

The contents of the stomach should be examined macroscopically, chemically, and microscopically. The macroscopic examination embraces the following:

1. Amount.—The quantity withdrawn through the tube or vomited depends upon the amount of food taken, the accumulation of food, and the time elapsing between the examination and the last meal. One hour after a test breakfast consisting of a dry roll and 300 c.c. of water, between 25 c.c. and 55 c.c. of contents should be withdrawn undiluted by Ewald's expression method. This applies to healthy conditions, as Boas as shown. Therefore, if a larger quantity is withdrawn, some defect of gastric motion or absorption may be suspected. If as large a quanity as 500 c.c. or 1000 c.c. of dark, offensive matter wells up through the tube, gastrectasia with pyloric stenosis may be suspected. A very small quantity found in the stomach or an empty stomach within two or three hours after a test meal of scraped beef, bread, and water is evidence either of a very hurried gastric peristalsis or a relaxed pylorus.

2. Consistency.—The consistency of the contents depends upon the amount of fluid and the character of the solid ingesta, as well as upon the absorption and motor power of the stomach.

3. Color.—This depends upon the color of the food eaten; as, for instance, red or blue berries impart their color to the contents. Blood may also stain the contents red or dark. Bile usually imparts a greenish-yellow hue. The color may be changed by different fermentations.

4. Odor.—The odor should be noticed. There may be none appreciable, while, on the other hand, the volatile acids, acetic and butyric, may impart their respective odors. Hydrochloric and lactic acids are not volatile, and are therefore inodorous. The copious, dark, frothy material withdrawn from a dilated stomach usually has a foul, yeasty, sickening smell that is almost characteristic. Drugs such as valerian, asafœtida, ethers, and camphor may be detected by their odors. Certain foods, such as onions, cauliflower, and oranges, impart their respective odors to the contents.

5. Mucus.—Vomited contents usually contain a considerable quantity of thick, ropy, tenacious mucus which comes from the throat and œsophagus. Mucus from the stomach is not, as a rule, so abundant

nor so tenacious and clear. Ordinarily it is present in a flocculent form, although sometimes it is present in a stringy condition, holding food particles in its meshes. It is not pigmented unless derived from the buccal, pharyngeal, or respiratory mucous membrane, in which case it has been swallowed. Sometimes it is blood-streaked, and in such cases it may have been swallowed or it may have come from the gastric mucosa. Not infrequently the stomach is the recipient of sputa which appear in the contents as frothy, isolated masses. Chemically, mucin may be separated by washing the mucus with cold water, which is then poured off and treated with a few drops of liquor potassæ, in a solution of which mucin is soluble, but from which it is precipitated by acetic acid even though the acid be in excess.

6. Blood.—A large quantity of bright arterial blood may be vomited or washed from the stomach, or it may be present in small quantities only, but still bright red and streaking the mucus or slightly staining the wash-water. Blood may be present in clots not entirely disorganized, or in the form commonly termed "coffee-grounds," in which the red cells have undergone disintegration. Red wine gives the stomach contents a blood color, and in cases of gastrectasia the stagnant contents often look like "coffee-grounds." Bile pigment may cause a brownish black color, and some preparations of iron will impart a blood-like color to the gastric contents. Tea leaves or blackened fragments of spinach or lettuce may simulate changed blood elements. It should be remembered that blood from the œsophagus, throat, mouth, nose, or lungs may be swallowed and afterward vomited or withdrawn by means of the stomach tube; so the presence of blood in the gastric contents is not positive proof of gastrorrhagia. The detection of blood in the gastric contents may be accomplished by the aid of the microscope, which reveals the red blood-corpuscles, provided they are not broken up, or its presence may be shown by the guaiacum test: To a small quantity of the stomach contents in a test tube one to four drops of tincture of guaiacum are added, and ozonic ether is floated on the surface; at the point of contact a blue color is seen if blood is present. When the red blood-corpuscles are disorganized and the hæmoglobin is transformed into insoluble hæmatin, the diagnosis may be made by Teichmann's test for hæmin crystals. Hæmatin in combination with hydrochloric acid forms microscopic, brown, rhombic crystals. Place some of the black sediment upon a microscope slide and add to it a crystal of sodium chloride and one or two drops of glacial acetic acid; cover and heat to a point below boiling, and in a short time, if blood coloring matter is present, crystals of hydrochlorate of hæmin may be seen through the microscope. If the patient has not taken iron, that substance may be searched for. Its presence may be demonstrated by the Prussian blue test. Some of the dark sediment is put in a porcelain capsule, a little potassium chlorate is added and also a few drops of hydrochloric acid. Heat is then applied, and a few drops of a 5 per cent. solution of potassium ferrocyanide are added; in the presence of blood Prussian blue is developed.

7. Pus is sometimes present in the stomach contents. It may come from the rupture of an abscess into the stomach, or it may gain access to the stomach from the œsophagus, pharynx, nose, lungs, or mouth.

Commonly it is present in the form of muco-pus from nasal and post-nasal catarrh or muco-purulent expectoration. In rare cases of phlegmonous gastritis pus is present. If in large amounts, it may be detected by the naked eye, but if in minute quantities, the microscope will reveal pus cells.

8. Detached portions of mucous membrane should be searched for. They are sometimes discovered in the wash-water in gastric erosions; they may come from the ragged edge of an ulcer, or pieces may be torn away by suction into a sharp-edged fenestrum of the tube. Small fragments from a carcinoma may be found and should be preserved for microscopic examination.

9. Food.—The food should be closely inspected to determine whether or not it has been acted upon by the gastric juice and saliva. If it has undergone digestion, the solid elements will be well milled and in a state of disintegration. The fragments of meat will be much softened and present a gelatinous appearance on the outside. Bread should be separated into fine particles, and other starchy food should be broken up and in partial solution. Coagulated egg albumin frequently resists the action of the gastric juice a long time. Sometimes the food is withdrawn from the stomach practically in the same condition as when it was swallowed; it is simply water-soaked and undigested. The comminution of the food depends upon the size of the morsels as well as upon the time spent in mastication. Thus we may with accuracy determine the table and masticatory habits of the patient.

Chemical Analysis.—*Acidity.*—It is necessary first to ascertain whether or not the stomach contents are acid, and for this purpose blue litmus paper may be employed. The normal acidity turns litmus very red, and the redness persists after the paper dries. If the change is only slight, the acidity is probably subnormal, as litmus is changed by the combined as well as the free acids; this, however, will be determined by testing the total acidity. The next step consists in testing for free acids, and first for free hydrochloric acid.

Hydrochloric acid was first discovered in the gastric contents by Prout in 1824, and Schmidt afterward confirmed his observation, and also ascertained that free as well as combined hydrochloric acid was present. With few exceptions since that time observers have agreed that this is the essential acid of the stomach. It is secreted by the gastric glands, and under normal conditions its secretion is caused by direct excitation, as, for instance, from the presence of food or from other irritation. Soon after food enters the stomach hydrochloric acid is poured out, and it first neutralizes the alkalinity of the stomach contents. Then it combines with the soluble proteids until they are saturated, after which it appears free in the proportion of 0.14 to 0.24 per cent. Leube says that thirty pounds of gastric juice are produced daily in a healthy adult stomach. This secretion contains 0.2 per cent. of hydrochloric acid. Chittenden says that four and a half litres of 0.2 per cent. hydrochloric acid are required for the digestion of a hundred grammes of proteids, and still no free acid appears.

A number of reagents are used to detect free hydrochloric acid, but some of them react in the presence of organic acids, and are consequently misleading in their results; therefore the reagents that indicate the

presence of hydrochloric acid only will be first considered. Of these Günzburg's reagent is one of the most valuable. It has been widely used, and is probably the best known test for free hydrochloric acid. In 1887, Günzburg announced its character and usefulness, and in the same year Ewald published his first recommendation of it. Its chief merits are, first, that it yields its characteristic reaction to free hydrochloric acid and to no other free or combined acid found in the stomach; second, its reaction is not interfered with by the presence of other acids, acid salts, proteids, carbohydrates, nor fats; third, the reaction occurs though free hydrochloric acid be present in as small an amount as 0.05 per mille (1 in 20,000). The following is the proper solution:

Phloroglucin,	2.0 (gr. xxx);
Vanillin,	1.0 (gr. xv);
Alcohol, absolute,	30.0 (f℥j).

When freshly made this solution has a light yellow color, which is stable for a long time if kept in a dark brown or black bottle; it slowly changes to a reddish brown on prolonged exposure to light. It has a pleasant odor of vanilla. In the presence of free hydrochloric acid a bright red color is struck upon evaporation by heat, this change depending upon the presence of vanillin. If concentrated hydrochloric acid is added to a drop of the reagent, rose red crystals are at once formed, but with the proportion of hydrochloric acid in the stomach contents this never occurs, it being necessary to evaporate the mixture to dryness over a water bath or flame. The test is very quickly applied, requiring only a few minutes to determine the presence or absence of the acid. Filtration of the contents is not necessary, it sufficing to fill a porcelain capsule with them and then empty it, allowing the liquid portion adhering to the surface of the capsule to remain. Three or four drops of the reagent are then poured into the capsule and mixed thoroughly with the residual contents by slight tipping and agitation. The capsule is then held over the flame from a Bunsen burner and its contents slowly evaporated. If hydrochloric acid is present, a bright red color appears at the edges of the mixture, and this deepens and spreads down to the centre. Care should be exercised against applying too great heat, else the contents will turn brown or black, being burned instead of simply evaporated to dryness. The intensity of the red color varies according to the amount of free hydrochloric acid present; it may be a faint reddish tinge, only perceptible upon complete evaporation in case the acid is present in minute quantity, or it may be a brilliant red, coming quickly upon the application of heat and spreading in deep red waves over the whole surface of the capsule. Its behavior in this regard affords some information as to the amount of free hydrochloric acid present, but, of course, only a rough estimate. Although not necessary to obtain the reaction, it is always desirable for nicety of technique to filter the contents and use about equal parts of the filtrate and the reagent—four or five drops of each.

In 1888, Boas announced resorcin a good reagent for the detection of hydrochloric acid. The following solution is used:

Resorcini resublimati,	5.0 (gr. lxxv);
Sacchari albi,	3.0 (gr. xlv);
Spiritus diluti,	100.0 (f℥iiiss).

A few drops of this are added to an equal amount of filtered gastric contents in a porcelain capsule and slowly evaporated to dryness over a flame. In the presence of as small a quantity as 0.05 per mille of HCl a red color appears. This is a valuable test, as it is reliable and the reaction does not occur to organic acids nor is it interfered with by any substance found in the stomach. In case phloroglucin and vanillin cannot be readily obtained, the resorcin solution may be quickly made, and serves as well as Günzburg's reagent, besides being much cheaper. Julius Friedenwald concludes that Boas' reagent is preferable to Günzburg's, being more stable, quite as reliable, and more easily obtained.

When hydrochloric acid is added to a solution of ferric acetate and potassium sulphocyanide a brownish red color is produced, owing to the formation of sulphocyanide. This is Mohr's test, and in detail consists of the addition of 0.5 c.c. of a neutral solution of acetate of iron to 2 c.c. of a 10 per cent. solution of sulphocyanide of potassium, and diluting the mixture with water to 20 c.c. A few drops of this reagent are placed in a porcelain capsule and spread thinly over its surface; then, drop by drop, the filtered stomach contents should be allowed to flow down the side of the capsule. At the junction between the two liquids a "peach red" color is seen if hydrochloric acid is present. Or some of the reagent may be put into a test tube and the filtrate floated upon its surface, when the brownish red color will be seen between the liquids.

We have used tropæolin 00 as a test for free acids and acid salts, but have not relied upon it as a test for free hydrochloric acid. It is a yellow aniline dye, making an orange-colored solution with dilute alcohol. This is changed to a pinkish red or dark brown on the addition of free mineral acids unless they are present in concentration. Acid salts are said to change it to a straw yellow, but usually no color change is perceptible other than would occur from dilution.

A new test for the detection and quantitative estimation of free hydrochloric acid was recommended by Töpfer in 1894. Julius Friedenwald published the results of his use of this reagent in the *Medical Record*, Apr. 6, 1895. Dimethylamidoazobenzol is the substance used, a 0.5 per cent. alcoholic solution being employed. It is a light, brown powder of a somewhat aromatic odor, and its solution is reddish brown. To a few cubic centimetres of gastric filtrate, in a test-tube, porcelain capsule, or beaker, from one to four drops of the reagent are added, when a rose red color is produced if hydrochloric acid is present. The test is very delicate, and will answer in the presence of only 0.004 per cent. of the acid. Friedenwald considers it more sensitive than either Gunzburg's or Boas' reagents, and almost as delicate as Leo's calcium carbonate test for the quantitative estimation of free hydrochloric acid. Dimethylamidoazobenzol reacts to HCl only when the latter is in a free state; its reaction is not interfered with by the presence of albuminous compounds, acid salts, peptone, sodium chloride, grape-sugar, or starch. It does not give any reaction to organic acids except when they are

present in a concentration of from 0.5 to 0.8 per cent., according as to whether or not albumin or peptone is present in the mixture, it being found that their presence renders necessary a higher concentration of the organic acids in order to give a reaction. We find Töpfer's reagent delicate, reliable, and admirably suited for quick quantitative and qualitative work. Einhorn finds that Töpfer's reagent turns red in the presence of 0.1 per cent. of lactic acid, but considers it useful for quantitative work, after HCl has been shown to be present by Günzburg's reagent.

The Detection of Free Acids.—For the determination of the presence or absence of free acids several reagents are used. Litmus should not be employed for this purpose, as it is changed by combined acids.

Congo Red.—This may be used in solution, or strips of filter paper may be dipped into a saturated aqueous solution of the dye and allowed to dry. Free hydrochloric acid turns it blue, and organic acids change it to a violet when the respective acids are used separately and in pure solution. The difference in color is not, however, sufficiently well marked when applied to the gastric contents to enable us to determine positively whether the color change is due to hydrochloric or to organic acid. No reaction is noticed in the presence of combined acid. It is therefore merely a reliable test for free acid.

Benzo-Purpurin 6. B.—A saturated solution of benzo-purpurin 6. B. in water is dark red in color. Strips of filter paper may be dipped into it and allowed to dry. If a paper is then dipped into the gastric contents, the color changes to brownish black, indicating the presence of free acid.

Methyl Violet.—This dye has a reddish violet color in weak aqueous solution, which is changed to a light blue on the addition of a gastric filtrate containing free acid.

Testing Total Acidity.—In estimating the total acidity of the stomach contents phenolphthalein is an admirable indicator. It is made from phthalic acid and phenol, is a buff colored powder, making in alcohol a slightly opalescent solution, which remains unchanged in color in acid or neutral media, but assumes a carmine when in an alkaline medium. To 10 c.c. of thoroughly mixed, unfiltered stomach contents one or two drops of a 5 or 10 per cent. alcoholic solution of phenolphthalein are added. Then from a burette a decinormal sodium hydrate solution is slowly added until the contents turn a pink color, at which indication the flow from the burette is checked. Agitation of the vessel containing the stomach contents should be made as the soda solution drops from the burette, in order to ensure thorough mixture. The number of cubic centimetres of soda solution required to neutralize 10 c.c. of stomach contents is then ascertained, and the result is expressed as percentage. Under normal conditions one hour after an Ewald test breakfast consisting of a roll and a glass of water from 4 to 6.5 c.c. should be required to neutralize 10 c.c. of the contents, and this may be expressed as an acidity of from 40 to 65 per cent. Thus, for example, if 5 c.c. of soda solution are added to the contents, and at that point they assume a pink hue which does not disappear upon shaking, the result should be expressed as 50 per cent. total acidity. Deci-

normal sodium hydrate solution is made by dissolving four grammes in one litre of distilled water.

Töpfer adopts another method of testing total acidity, which is as follows: Put 10 c.c. of stomach contents in a beaker, add three or four drops of the 1 per cent. aqueous solution of sodium alizarin sulphonate, and then add decinormal sodium hydrate solution until a violet tint appears corresponding in depth to that produced by the addition of 4 drops of alizarin solution to 5 c.c. of 1 per cent. solution of sodium carbonate.

Determination of the Total Amount of Free Hydrochloric Acid.—Mintz's method for the quantitative determination of free hydrochloric acid is based upon the estimate that the limit of Günzburg's reaction is 0.03646 per mille HCl (1 c.c. decinormal soda solution to 100). He has also demonstrated that when decinormal sodium hydrate solution is added to albuminous mixtures like stomach contents, the alkali first combines with the free hydrochloric acid. The test is conducted as follows: To 10 c.c. of gastric filtrate in a beaker decinormal soda solution is slowly added from a burette; at frequent intervals the titration is checked and the contents examined with Günzburg's reagent to ascertain whether or not all the free hydrochloric acid has been neutralized. Finally, the phloroglucin-vanillin reaction no longer occurs, and at that point the calculation is made. For instance, if after 3.4 c.c. of soda solution have been added Günzburg's reaction is faint but positive, while after 3.5 c.c. have been added the reaction does not occur, the reading 3.4 c.c. is calculated as the limit of the reaction. If 3.4 c.c. neutralize the hydrochloric acid in 10 c.c. of gastric contents, it is plain that 34 c.c. will neutralize the free hydrochloric acid in 100 c.c.; therefore by multiplying 0.003646 by 34 the percentage of free hydrochloric acid is found to be 0.12.

Mintz's method is laborious and consumes more time than Töpfer's, which is accomplished with greater despatch than any quantitative test for HCl known to us. Two or three drops of Töpfer's solution of dimethylamidoazobenzol are added to 10 c.c. of gastric contents in a beaker, and decinormal soda solution is allowed to flow in drop by drop until the red color entirely disappears and a yellow color takes its place. The number of cubic centimetres of soda solution required to neutralize the free hydrochloric acid in 100 c.c. of stomach contents is used to multiply 0.00365, and the result expresses the percentage of hydrochloric acid. For example, let us take an instance from our record books: 4 c.c. of soda solution were required to dissipate the red color of the contents subjected to examination; then 0.00365 was multiplied by 40, the result equalled 0.14 per cent. free hydrochloric acid, the lower normal limit.

Calcium carbonate is not decomposed by acid salts, but forms a neutral solution of calcium chloride with free hydrochloric acid, and upon this fact is based Leo's quantitative test for HCl. The stomach contents are first extracted with ether to remove the lactic and fatty acids, and then a small quantity of the contents is mixed with some chemically pure calcium carbonate and the reaction tested with blue litmus paper. A strip of litmus that has previously been dipped in the gastric contents is used as a standard. Compare the two papers. If

the litmus no longer reddens after the calcium carbonate has been added, then the acidity depends upon free hydrochloric acid; if the litmus is reddened the same as the control paper, the acidity is due entirely to acid salts. When it is ascertained that the acidity is due entirely to free hydrochloric acid, the amount may be very easily determined by titration in the manner already described.

Estimation of Free and Combined Hydrochloric Acid.—Sjöqvist's method is based upon the fact that barium carbonate combines with the chlorine of the bound hydrochloric acid of the stomach contents, forming barium chloride. The organic acids form barium carbonate. The former is soluble in hot water, the latter insoluble. Accordingly, the barium chloride is dissolved and precipitated again by adding soda; after it is collected it is once more converted into barium chloride by the addition of hydrochloric acid; the mixture is evaporated to dryness, and the residue is dissolved in water and titrated with silver nitrate with addition of potassium bichromate. 0.001 c.c. of sodium chloride is represented by 1 c.c. of NO_3Ag solution, and the calculation is made according to the formula: $x : t = 36.5 : 58.5$; $t =$ number of cubic centimetres of silver solution employed. Thus, 10 c.c. of the gastric filtrate are placed in a platinum capsule and 0.5 gramme of barium carbonate added; the mixture is then reduced to ash. After cooling, the residue is dissolved in 50 c.c. of boiling water and filtered. The barium chloride is then precipitated as barium carbonate by the addition of several drops of concentrated soda solution. Filtration is again practised; the precipitate is washed, dissolved in water, and titrated with NO_3Ag solution, the estimate being made according to the formula given above. If phosphates or chlorides are present in excess, they may interfere with the accuracy of the test.

For the employment of Luttke's method two solutions are required:

1. Decinormal solution of argentic nitrate, 16.997 grammes of NO_3Ag, C. P., in 900 c.c. of 25 per cent. NO_3H; 50 c.c. of liquor ferri persulphatis (B. P.) are added, and the mixture diluted to 1000 c.c. with water.

2. Decinormal solution of ammonium sulphocyanite containing 7.6 grammes to the litre. Upon mixing 10 c.c. of each solution a reddish color should appear. The first step consists in the determination of the total chlorine, and second of the chlorides. To 10 c.c. of the gastric contents 20 c.c. of the silver solution are added; the mixture is diluted with water to 100 c.c. and filtered. The precipitate on the filter contains the chlorine with silver, while the filtrate represents the excess of silver solution used. Ammonium sulphocyanite solution is now added to 50 c.c. of the filtrate until a red color appears. Now multiply by 2 the number of c.c. used, and that will equal the number of c.c. of silver solution used in excess. The amount of chlorine combined with silver is then estimated.

Ten c.c. of gastric contents are evaporated to dryness in a platinum capsule; the residue is ignited and the chlorides are extracted by grinding the ash with 100 c.c. of hot water. Filter and add 10 c.c. of silver solution to the filtrate. The excess of silver used and the amount of chlorine may be estimated as in the former process. Subtract the chlorines in the form of chlorides from the total chlorine, and the resulting

number, multiplied by 0.0365, gives the hydrochloric acid in 100 c.c. of stomach contents.

The Heyner-Seeman Method.—Ten c.c. of gastric filtrate is neutralized with decinormal sodium hydrate solution (*e. g.* 6 c.c.); it is reduced to ash and the ash dissolved in water, filtered, and the same quantity of decinormal hydrochloric acid solution (each c.c. contains 0.00365 gramme HCl) as was used of the soda solution (*i. e.* 6 c.c.) is added to the filtrate. Phenophthalein is added, and the mixture is titrated with decinormal soda solution; if 2 c.c. should be required for neutralization, 20 multiplied by 0.00365 equals combined HCl. 0.073.

A very complicated method has been devised by Hayem and Winter in which three separated determinations are made: first, the total amount of chlorine; second, the total chlorine less that which is volatilized upon heating at 100 c.c.; third, the chlorides combined with mineral bases.

Lactic Acid.—Lactic acid is formed in the stomach by fermentation or it is taken preformed in the ingesta. Sarcolactic acid is preformed in animal flesh, and therefore is not the result of lactic acid fermentation in the stomach. Upon an ordinary diet including many products of the bakery lactic acid is frequently present in the stomach during the first thirty or forty minutes after a mixed meal or Ewald's test breakfast. If a mixed meal contains a large quantity of starch and milk-foods, lactic acid usually prevails longer than forty minutes. When free hydrochloric acid appears, lactic acid usually disappears, although the two acids may be present together; indeed, sometimes lactic acid is found three or four hours after a meal.

Ewald and Boas stated that lactic acid was a normal constituent of the gastric contents during early digestion, but Martius and Luttke denied that, and demonstrated its absence from the stomach at all times during normal digestion. They found at five-minute intervals after a test breakfast that the total acidity and the amount of hydrochloric acid were precisely the same, and by this indirect method lactic acid was excluded.

Boas reinvestigated the whole matter, and discovered that the reason lactic acid was found during the early part of digestion on ordinary diet was owing to the fact that it was introduced preformed into the stomach. Uffelmann's reagent was discarded as a test, owing to its reaction with other substances not infrequently taken into the stomach—as, for instance, glucose, phosphates, and tartrates—and also because it is a comparative color test and different shades of yellow give rise to confusion. Boas therefore adopted a new test for the detection of lactic acid, by means of which the lactic acid is decomposed into aldehyde and formic acid, and the former is detected as iodoform in an alkaline iodine solution. By this test Boas determined that products of the bakery contain an appreciable amount of lactic acid preformed, and therefore he gave a test meal in which none was discoverable. This consists of a gruel made with a tablespoonful of oatmeal flour to a litre of water and flavored with a little salt. Friedenwald says Boas uses Knorr's "Hafermehl" on account of its pleasant taste.

Using this test meal, Boas found that lactic acid is not a normal constituent of the stomach contents at any stage of digestion. It is

absent at all periods, both early and late. Furthermore, he found that even in the absence of free hydrochloric acid, with food stagnation, with benign pyloric stenosis, gastrectasia, chronic catarrhal gastritis, and other morbid conditions, lactic acid was very rarely present. In gastric carcinoma, however, it was present in large quantities, and in this disease alone it was demonstrable. This subject will be further considered in the chapter on Carcinoma of the Stomach (page 150).

Uffelmann's Test.—Ten c.c. of a 4 per cent. solution of carbolic acid are mixed with 20 c.c. of distilled water, and a few drops of liquor ferri chloridi are added; this makes an amethyst blue solution. The gastric filtrate is added to this in a porcelain capsule or upon some other white surface, and if lactic acid is present a distinct canary yellow is developed. The reaction depends upon the presence of the iron, as dilute solutions (almost colorless) of neutral ferric chloride turn canary yellow on the addition of lactic acid; the carbolic acid is used to intensify the color change. Uffelmann's reagent responds to a 0.05 per mille (1 in 20,000) solution of lactic acid. Ewald points out that lactates, phosphates, sugar, and alcohol also give a yellow color, and the test is, therefore, not free from sources of error. In order to ensure accuracy the gastric filtrate should be extracted with ether by shaking 5 or 10 c.c. with ether, pouring it off into a beaker, and evaporating to dryness over a water bath. Several portions of ether should be used, and the contents shaken separately with each in order to be sure of extracting sufficient lactic acid to give a good reaction. The residue is then dissolved in a little water and Uffelmann's test applied. It should be borne in mind that all color reactions to this test other than distinct canary yellow are not indicative of lactic acid; *e. g.* the yellow color of the stomach contents imparts a yellow color to the blue solution, and excess of butyric acid changes it to a brownish yellow, but neither of these is a canary yellow.

Manges mentions Leo's test for lactic acid as being a good one. It consists in driving off the volatile acids (acetic and fatty acids) by boiling the stomach contents until litmus paper held in the vapor no longer turns red. The water lost by evaporation is then replaced, the contents cooled and extracted with ether, the residue redissolved and tested for lactic acid with Uffelmann's reagent.

Boas' Method.—This is qualitative and quantitative. The qualitative estimation is as follows: The gastric filtrate is first tested for free acids, and if they are found present an excess of barium carbonate is added. Ten c.c. of the filtrate is then evaporated to the consistency of syrup, a few drops of phosphoric acid are added, and the carbon dioxide is removed by boiling for a few moments. It is now allowed to cool, and extracted two or three times with 50 c.c. of ether (absolutely free from alcohol), digested half an hour, the layer of the ether poured off, evaporated, and the residue dissolved in 45 c.c. of water; this may be filtered if necessary. This is poured into a flask and treated with 5 c.c. of concentrated SO_4H_2 and a little manganese dioxide. A glass tube leads from this flask into a chamber containing an alkaline iodine solution which is made by mixing equal parts of decinormal iodine solution and decinormal sodium hydrate solution. Heat is applied to the flask, and as the mixture boils the iodine solution grows smoky and

the odor of iodoform is detected—*i. e.* if lactic acid is present in the gastric filtrate.

For the quantitative estimation the following reagents are necessary: (*a*) $\frac{1}{10}$ N. iodine solution; (*b*) $\frac{1}{10}$ N. sodium arsenite solution; (*c*) hydrochloric acid of a specific gravity 1.018; (*d*) 56 grammes of potassium hydrate to 1000 c.c. of water; (*e*) solution of starch paste freshly made.

The watery solution of the ethereal residue of the gastric filtrate, with the sulphuric acid and the manganese dioxide, is now carefully distilled until four fifths of the contents of the flask have passed over into 20 c.c. of water. Alkaline iodine solution is now made by mixing equal parts (*e. g.* 10 c.c.) of decinormal iodine solution and the KOH solution above mentioned, and 10 c.c. of this are added to the distillate: 20 c.c. of the hydrochloric acid solution are then added, and sodium bicarbonate in excess is next added. The decinormal sodium arsenite solution is now added, and then decinormal iodine solution by titration until a permanent blue color appears. Now, it is desired to find the amount of iodine used in forming iodoform, and this is determined by subtracting the number of cubic centimetres of alkaline iodine solution employed, and by multiplying the result by .003388 the amount of lactic acid is determined; 1 c.c. of decinormal iodine solution equals .003388 of lactic acid. For instance: 10 c.c. of $\frac{1}{10}$ normal iodine solution is first used, and 6 c.c. of $\frac{1}{10}$ normal sodium arsenite solution are added: 0.4 c.c. of iodine are required to titrate back. 10 c.c. + 0.4 = 10.4 c.c. iodine solution used; 10.4 c.c. − 6 c.c. = 4.4 c.c. × .003388 = .0149 for 10 c.c., or 0.149 per cent.

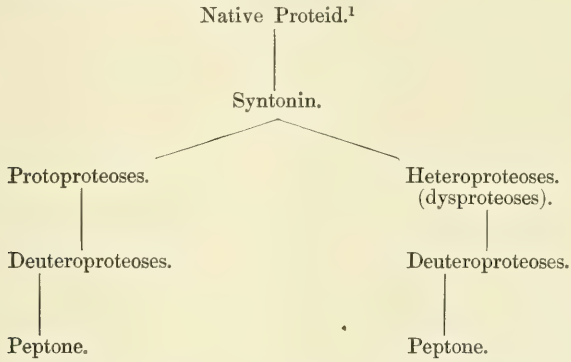
Acetic and Butyric Acids.—These acids are volatile and are detected by distillation. As the gastric filtrate is evaporated the fumes arising smell of either acetic or butyric acid if one or the other is present, but if both are present the odor test is unsatisfactory. 50 c.c. of the gastric filtrate are slowly distilled in a retort connected with a condenser leading into a receiving flask. When three fourths or four fifths have passed over the remainder is diluted again to 50 c.c., and distilled until three fourths have passed over. In the flask there is now a solution of the volatile acids. Acetic acid is more readily soluble than butyric acid, and the latter is often seen in small oily droplets on the surface of the liquid. Acetic acid strikes a blood-red color on the addition of a solution of ferric perchloride. If a small amount of alcohol and a couple of drops of sulphuric acid are added to a few cubic centimetres of the distillate, acetic ether is formed upon the application of heat for a short time. Butyric acid may be recognized by its odor of rancid butter, which is intensified by evaporation of a portion of the distillate. The addition of sulphuric acid and alcohol in the manner described gives rise to the formation of butyric ether, which has a characteristic pine-apple smell. Butyric acid also changes Uffelmann's lactic acid reagent a brownish yellow.

A quantitative estimation of the volatile acids may be made as follows: 10 c.c. are neutralized by decinormal sodium hydrate solution, using phenolphthalein as an indicator. If 3 c.c. of soda solution are required for neutralization, the result may be reckoned: 100 c.c. of decinormal soda solution correspond to 0.32 gramme of acetic acid; therefore, 1 c.c. = .0032 gramme and 3 c.c. = .009 gramme. Now,

if the whole distillate amounts to 60 c.c., the acetic acid equals .064 gramme, which represents the quantity in the original 50 c.c. of the gastric filtrate; if 50 c.c. = .064, 100 c.c. = .128 gramme per cent. The volatile acidity is here reckoned as due to acetic acid, which suffices for practical purposes.

The Digestion of Albumin.—This is accomplished by pepsin and hydrochloric acid. Neither of these acts alone to digest albumin. Pepsin may act in the presence of acid other than hydrochloric, but not as perfectly nor as rapidly. The process of albumin digestion is called proteolysis. As soon as food enters the stomach pepsin and hydrochloric acid are secreted; the albumin first combines with the acid to form syntonin, which is further changed into the proteoses by the combined action of pepsin and hydrochloric acid.

A number of products are formed midway between syntonin and peptone. This constitutes a process of hydrolysis and cleavage which is well represented by the following scheme:



Normally, these proteoses are formed in the presence of gastric digestion. Each one is a distinct chemical body, having its own definite proportion of carbon, hydrogen, nitrogen, sulphur, and oxygen, the percentage of these elements differing in the proteoses of different forms of albumin—blood, fibrin, paraglobulin, egg albumin, caseine, myosin, elastin, gelatin, etc.[2]

It is not sufficient, therefore, to speak of propeptone as representing all these forms midway between the native proteid and peptone in proteolysis. If these substances are found in the stomach contents, they afford evidence of pepsin-hydrochloric acid digestion, and it is therefore important that we should know how to detect and separate them. Syntonin is precipitated from the gastric filtrate by neutralization, and after precipitation is complete it should be filtered out. If proteoses are then present, the addition of nitric acid, drop by drop, to the neutralized fluid will result in a white precipitate which is dissolved on heating, but reappears on cooling. Or, instead of using the acid, we may add crystal of rock salt to saturation, and this usually results in precipitation. If the primary proteoses are absent, no precipitation will occur by either of the above methods employed alone, but if rock

[1] R. H. Chittenden's *Cartwright Lectures on Digestive Proteolysis.*
[2] Kuhne and Chittenden. See Chittenden's *Cartwright Lectures.*

salt is used to saturation of the neutralized fluid, and then the acid is added, a precipitate will be thrown down which will consist of a part of the deutero-proteose present in the fluid. Protoproteose is soluble in plain water, but heteroproteose is only soluble in alcohol, acid, and salt solutions. Proteoses are not coagulated by heat nor by alcohol, they are, however, precipitated by alcohol as well as by potassium ferrocyanide, acetic acid, picric acid, cupric sulphate, plumbic acetate, metaphosphoric acid, and ammonium sulphate.

In order to determine whether peptone is present it is necessary, first, to precipitate the proteoses completely by the addition of ammonium sulphate, and then to separate them by filtration. Ammonium sulphate is best used for this purpose, because peptone is not affected in the slightest degree by that reagent in any medium. In precipitation of the proteoses there is one body that it is difficult to get rid of before applying the test for peptone, and that is deuteroproteose, all traces of which may be precipitated only by boiling for a long time with ammonium sulphate added to saturation. If the clear filtrate is now free from primary and mid-products of digestion, peptone is detected by adding an excess of potassium hydroxide and a few drops of dilute cupric sulphate. This gives rise to a pure red color, the reaction being strong or weak in proportion to the amount of peptone present. The method of precipitating the peptone is too complicated for insertion here, and belongs rather to the work carried on in a well-equipped physiological laboratory.[1] When separated, peptone is a yellowish hygroscopic powder of bitter taste. For ordinary clinical purposes the biuret test is a good one to discover the presence or absence of the proteoses and peptone in the gastric filtrate.

The addition of cupric sulphate to an alkaline solution of albumoses and peptone gives a purple red color. This is called the biuret reaction. For the sake of dispatch, especially in office practice, this reaction is obtained most satisfactorily by the addition of Fehling's solution, drop by drop, to one third or one half of a test tube of gastric filtrate held up to the light.

These substances found in the gastric filtrate afford a knowledge as to the digestive power of the stomach. But little peptone is found ordinarily after a test meal; proteoses, however, are usually present in considerable quantities. The reasons that peptone is found only in small quantities may be that the proteoses or peptone are absorbed as fast as they are formed. A certain amount of proteose resists further action and does not go on to the formation of peptone.

When we speak of the absorption of proteoses and peptone, it should be remembered that they probably undergo some further change during absorption before they reach the blood current, because they act as poisons when introduced directly into the blood. It is interesting to note that the toxins formed by bacteria are proteose-like substances bearing a resemblance to the peptones and proteoses formed by pepsin proteolysis.

Determination of Digestive Activity by the Gastric Filtrate.—When food is withdrawn from the stomach after it has been subjected to the action of the gastric juice for an hour or longer and the biuret reaction

[1] See R. H. Chittenden: *Cartwright Lectures*, 1894.

is obtained, and free hydrochloric acid found together with properly disintegrated food elements, there is sufficient warrant for believing that the gastric juice has been active. These findings contrast strongly, for instance, with those obtaining in "achylia gastrica" (p. 116), a condition in which there is a total absence of hydrochloric acid, digestion is held in abeyance, and the food is washed from the stomach in a water-soaked and undigested state, none of the products of proteolysis being present. It seems hardly necessary to use the incubator in estimating the digestive activity of the gastric juice when the stomach itself is the natural and most valuable test oven we can employ. If, however, it is desired to investigate the digestive activity of the gastric juice outside the stomach, then thin slices of white of egg may be added to four test tubes, the first containing simply the gastric filtrate; the second two drops of hydrochloric acid, c. p., with 2.5 c.c. of the stomach contents the third containing the filtrate and 0.2 of pepsin added to it; while to the fourth tube both hydrochloric acid and pepsin are added. All the test tubes are then placed in an incubator and kept at a temperature of 100° F. They should be examined at intervals, and it will then be seen whether the filtrate alone is or is not sufficient to digest the egg albumin, whether the hydrochloric acid added to the second tube was needed or not, or whether the pepsin increased the activity in the third tube, etc.

For clinical work such investigation is unnecessary as much more valuable information is obtained by allowing the stomach to act as best it will on certain foods, and then by withdrawing the contents and subjecting them to analysis we arrive at a very reliable estimate of the digestive power of the stomach.

Rennet Ferment or the Milk-curdling Ferment, and Rennet Zymogen.— Besides pepsin and its enzyme the rennet ferment is formed in the stomach. It has the property of coagulating milk, but its proenzyme has no action itself upon milk. If, however, hydrochloric acid or calcium chloride is added to the filtrate containing the rennet zymogen, it is converted into a ferment and curdles the milk.

The rennet ferment may be detected in the gastric filtrate by the following simple method: First carefully neutralize 10 c.c. with decinormal sodium hydrate solution and add 10 c.c. of neutral milk; the mixture should then be placed in an incubator at 38° C. In from ten to fifteen minutes a casein coagulum is formed if the rennet ferment is present, and this coagulum is unbroken and floating in the clear whey.

In other words, the coagulation is not flocculent in character. The rennet zymogen is detected by first making slightly alkaline 10 c.c. of gastric filtrate, and then adding to that 2 c.c. of 1 per cent. solution calcium chloride. Ten c.c. of neutral milk are added and the mixture is placed in an incubator. If the zymogen is present, a casein coagulum will be formed in from five to fifteen minutes.

The quantitative examination of rennet ferment is made by diluting the neutralized gastric filtrate with distilled water in separate portions up to $\frac{1}{10}$, $\frac{1}{15}$, $\frac{1}{20}$, $\frac{1}{25}$, $\frac{1}{30}$, etc. Five c.c. of each dilution are placed in separate beakers, an equal quantity of neutral milk being added. The mixtures are then placed in a chamber at a temperature of 38° C. If a casein cake is formed in the beaker containing dilution $\frac{1}{25}$, and not in

the beaker with dilution $\frac{1}{30}$, it is evident that the rennet ferment is no longer active beyond the $\frac{1}{25}$ dilution. It is not present, therefore, in sufficient quantities to be active in a dilution of 1 to 40, which is the normal limit.

The rennet zymogen is present in much larger quantities, and may be active in dilution of $\frac{1}{150}$. A portion of the gastric filtrate is made slightly alkaline, and separate quantities are diluted, $\frac{1}{10}$, $\frac{1}{15}$, $\frac{1}{20}$, $\frac{1}{25}$, $\frac{1}{30}$, $\frac{1}{35}$, $\frac{1}{40}$, $\frac{1}{45}$, $\frac{1}{50}$, etc. Five c.c. of the separate dilutions are placed in a number of beakers, and to each is added 1 c.c. of 1 per cent. solution of calcium chloride and 5 c.c. of milk. The point at which the zymogen fails to act is thus determined.

The quantitative estimation of both the ferment and the zymogen has of late assumed considerable importance in gastric chemistry, owing to the fact that in certain organic diseases of the stomach they are greatly diminished or the ferment is absent altogether, while in functional and mild disturbances the relative amounts of these important gastric constituents are rarely disturbed. Julius Friedenwald[1] after a careful study of this matter concludes that the milk-curdling ferment may be present in dilutions up to the $\frac{1}{40}$, and its zymogen up to $\frac{1}{150}$ under normal conditions. The ferment is usually greatly diminished in chronic gastritis, being lowered from $\frac{1}{12}$ to 0; while the zymogen is reduced as low as $\frac{1}{30}$ to $\frac{1}{3}$. In carcinoma the milk-curdling ferment is reduced to $\frac{1}{15}$ to $\frac{1}{5}$, and the zymogen to $\frac{1}{40}$ to $\frac{1}{15}$. In but few diseases of the stomach besides these is the rennet zymogen so markedly lowered. Indeed, it is present in plentiful quantities in secondary hyperæmic conditions of the stomach and the gastric neuroses, with or without the presence of free hydrochloric acid.

Starch Digestion.—Ptyalin, the salivary ferment, acts upon the starchy constituents of the food, changing them into grape sugar, and it also changes cane sugar into invert sugar. The action of ptyalin commences in the mouth during mastication, as may be demonstrated by thoroughly chewing for some minutes whole wheat or rice or some form of starch, which when first put into the mouth has not the slightest sweet taste, but a decidedly sweet taste is soon noticeable owing to the formation of sugar. Salivary action continues in the stomach until hydrochloric acid is present up to .01 per cent. This acid seems to exert the earliest and the most marked inhibitory effect upon the action of the ptyalin. Other acids must be present in the stomach in greater concentration before its action is checked. Lactic acid up 0.1 to 0.2 per cent. and butyric acid up to 0.4 per cent. is needed to produce a like effect. The digestion of amylaceous substances in the stomach lessens gradually after the beginning of gastric secretion, until it finally ceases, provided the stomach is sufficiently acid.

The mid-products of starch digestion are dextrin and maltose, there being two varieties of dextrin, erythrodextrin and achroödextrin. If undigested starch is present in the gastric filtrate, its presence may be detected by the addition of Lugol's solution (which is composed of iodine 1 part, potassium iodide 2 parts, aquæ destillatæ 200 parts), a deep blue or brownish blue color being produced. Achroödextrin, maltose,

[1] Julius Friedenwald: "The Quantitative Estimation of the Rennet Zymogen, its Technical Value in Certain Diseases of the Stomach," *Med. News*, June 22, 1895.

and dextrose do not yield any reaction to iodine, but in the presence of erythrodextrin a faint purple is seen. In the normal stomach one hour after the Ewald test meal we usually find sufficient undigested starch in solution in the gastric filtrate to give rise to a faint bluish or brownish-blue discoloration upon the addition of a drop or two of Lugol's solution. In cases of superacidity, on the other hand, this same shade is deepened and very pronounced, owing to the increased amount of undigested starch in solution. In cases of subacidity, if a large amount of undigested starch appears in the filtrate, it may be due to deficient mastication or to a poor quality or too small quantity of saliva.

Motor Activity of the Stomach.—In order to determine whether or not the motion of the stomach is sufficient several methods may be employed. One of these is the salol test, which originated with Ewald in 1887, and which consists in the administration of one gramme of salol during the period of digestion; it is best given in capsules. Salol is a compound of phenol and salicylic acid. It maintains its identity in an acid medium, but it is not stable in an alkaline medium, being here decomposed into salicylic and carbolic acids. It is therefore insoluble in an acid stomach, but being soluble in the intestine it liberates the salicylic acid, which is absorbed and eliminated in the urine as salicyluric acid, in which fluid it is detected by a violet color which is produced on adding liquor ferri chloridi. Small traces of it in the urine may be extracted with ether after the urine is acidulated with hydrochloric acid, and the ether extract may then be tested.

Ewald gives a method by which the merest traces of salicyluric acid may be discovered in the urine. A small quantity of urine is dropped upon a piece of filter paper, and a drop of 10 per cent. solution of the chloride of iron is let fall upon the moistened spot. A violet color appears at the edge of the drop if only a very small quantity of the salicyluric acid is present. Ewald found that in a great majority of cases salicyluric acid appeared in the urine in from sixty to seventy-five minutes after taking the salol, and disappeared at the end of twenty-four hours in healthy individuals. In cases of motor inactivity of the stomach it may last forty-eight hours or longer, the condition of the bowels appearing to exert no influence upon it.

This method has been severely criticised. The objection is raised that too many processes, mechanical, absorptive, and excretory, have to be allowed for in the estimation. The salol is to be expelled from the stomach, decomposed in the intestine, the salicylic acid absorbed, carried by the blood, perhaps by the lymphatic current, through the liver and lungs to the kidneys, by which organs it has to be excreted, and must then pass through the entire length of the urinary tract.

It must then be presupposed that all these functions are performed in a normal manner. We have always objected to this test chiefly for the reason urged by Sydney Martin, viz.—that a small amount of salol may pass through the pylorus with the fluids of the gastric contents, but that the mechanical power of the stomach is not thus tested, because the knowledge that is particularly desirable is in what period the stomach can empty itself of a mixed meal. Most of the salol may remain in the stomach, yet the test may yield its reaction, but give us no information as to the emptying power of the stomach.

A. L. Benedict,[1] having used this test very frequently and having been struck by what he terms the monotonous results obtained by its use, after studying its action in 16 cases and finding that the salicyluric acid reaction occurred anywhere from half an hour to three hours in subacidity of the stomach, says that "the conclusion seems justified that the appearance of salicylic acid after the administration of salol merely means that the latter has been absorbed somewhere, and that no practical deduction can be drawn, unless possibly from the occurrence of a very marked delay, but this delay does not often occur in the very cases in which we would most expect it." In answer to the argument that salol might be absorbed from the stomach and produce the characteristic urinary reaction, Ewald ligatured the pylorus of a dog and then gave the animal some salol. No salicyluric acid could be detected in the urine up to three hours, at which time the dog died. The result of this experiment is adduced as proof that salol is not absorbed by the stomach.

Klemperer in 1887 attempted to estimate the motor activity of the stomach by first washing out the organ and then pouring 100 c.c. of pure olive oil into it. Two hours afterward the oil which remained in the stomach was removed and measured. Seventy to 80 per cent. of oil should be expelled into the duodenum by a healthy stomach. This method has not been widely used in this country.

Max Einhorn[2] has devised a novel and ingenious instrument for measuring the motor activity of the stomach. This instrument he calls the gastrograph. The apparatus comprises a ball, a few electric cells, and a ticker. The ball consists of two hollow metallic hemispheres, one within the other, but perfectly insulated. The inner ball is furnished with spikes radiating in all directions, but not touching the inner surface of the outer hemisphere. Another small platinum ball lies within the outer hemisphere, rolling about from spike to spike, thus serving to close the current as it rests against a spike and lies upon the inside of the outer hemisphere. The least motion of the apparatus is sufficient to dislodge this small platinum ball, and it will roll from one spike to another, thereby interrupting the electrical current and setting the ticker in motion. If the apparatus is considerably agitated, the small platinum ball will be kept rolling, thus making numerous interruptions and causing numerous ticks to be recorded. By means of this very ingenious instrument Einhorn has investigated gastric motion under physiologic and pathologic conditions, and the findings seem to show that mechanical activity of the stomach in health is a factor of considerable importance—the stomach maintaining an almost constant motion while it contains food, the number of motions for three minutes averaging from 4 to 41, while in a fasting stomach they are considerably fewer. Under pathologic conditions one class of cases corresponds to the normal; another shows increased motion, the number of ticks in these cases being very numerous; and the third shows almost no motion whatever. The least motion occurred in gastro-succorrhea and in chronic gastritis with dilatation; while the most marked

[1] A. L. Benedict: "Salol Test for Gastric Atony," *Med. News*, Feb. 9, 1895.

[2] Einhorn: "The Gastrograph: A New Means of Determining the Mechanical Action of the Stomach," *New York Med. Journ.*, Sept. 15, 1894.

activity was noticed in a case with pyloric stenosis and dilatation of the stomach.

These methods above referred to are all valuable, but for clinical purposes it is quite sufficient to determine the motor power of the stomach by the amount of food remaining in the stomach three, four, or perhaps seven, hours after a mixed meal has been eaten. Ordinarily, a healthy stomach should empty its contents into the duodenum within five hours, unless a large amount of food in rather coarse form has been eaten. Three hours and a half or four hours after a breakfast consisting of Hamburg steak, dry bread, and water not more than ten grammes of solids remain in cases of good motor activity.

Absorption.—Absorption is under the influence of the nervous system. Sometimes fluids are very slowly or not at all absorbed by the gastric mucosa; and when water is drank in considerable quantities, it is present several hours afterward when the tube is passed. This is more common in those cases in which dilatation exists, with or without pyloric stenosis. In some cases salts, alcohol, and many substances in solution are undoubtedly absorbed rapidly from the stomach, in other cases absorption of these is largely abolished.

A convenient and ready test of the absorptive powers of the stomach is made by giving about three grains of potassium iodide in a gelatin capsule, the outside of which has been carefully wiped off. Strips of filter paper which have been previously dipped in starch paste and dried are then used every few minutes to test the patient's saliva, and when iodine is eliminated in the saliva the starched paper will be turned brown or a brownish blue. Under normal conditions iodine appears in the saliva in from ten to fifteen minutes, whereas in conditions of slow absorption its appearance may be delayed for more than an hour. The solubility of the gelatin should be determined by a control case.

Microscopic Examination of the Stomach Contents.—Numerous bacteria are found in the stomach contents. Hydrochloric acid if present in the free state somewhat retards the development and activity of bacteria, although it does not destroy them all. There are bacteria that may pass through the stomach unharmed, as, for instance, the staphylococcus aureus and the micrococcus tetragenes. This is probably true of the typhoid bacillus. The bacillus pyocyaneus, the bacillus lactis aërogenes, bacillus mycoides, and many others have been found in the stomach contents. Some of them peptonize and some coagulate the casein of milk. Micro-organisms causing acid fermentations are very commonly present, especially when there is an absence of free hydrochloric acid. The most prevalent of these is the bacillus acidi lactici. It is an aërobe and forms lactic acid, especially in the presence of sugar and dextrin. The bacillus butyricus is an aërobe, and gives rise to the formation of butyric acid in the presence of starch, dextrin, or cane sugar; it also changes lactic acid into butyric acid. Sarcina ventriculi may be found in the stomach contents, especially in the stagnating contents of gastrectasia. In appearance the sarcinæ resemble the form of cotton bales; they are not easily cultivated, and they probably give rise to the formation of some acid which is incidental to their growth.

Yeast spores may be found especially in the contents of dilated

stomachs, and become active in the presence of glucose and maltose, the fermentation resulting in the formation of minute quantities of alcohol and perhaps considerable quantities of acetic and carbonic acids.

Putrefaction may occur in the stomach when there is prolonged stagnation of the proteid foods, and putrefactive micro-organisms are then found in the gastric contents. Some of their products are very poisonous, especially the aromatic substances, ptomaïnes, and albumoses to which they give rise. Some of the symptoms of gastrectasis, as, for instance vertigo, nausea, and numbness of the extremities, may be due to the absorption of these noxious products.

GASTRIC NEUROSES.

Gastric Innervation.—The stomach is supplied by the pneumogastric nerves, the right passing along the œsophagus, on its posterior, and the left along its anterior, surface. They form the anterior and posterior gastric plexuses, two thirds of the posterior going to the abdominal organs. As they pass along the œsophagus they send small filaments into its structure, thereby forming plexuses which reach the stomach. The terminal filaments of the pneumogastrics form numerous anastomoses with the abdominal sympathetic nerves, with branches of which the stomach is richly supplied. From the cœliac plexus the sympathetics branch to form secondary plexuses—viz. the coronary, the hepatic, and the inferior coronary, which accompany, respectively, the left coronary, the right coronary, and the right gastro-epiploic arteries. The ganglionic supply is present in the form of Auerbach's plexus myentericus and Meisner's plexus submucosus. This complex nerve supply in the stomach presides over secretion, motion, absorption, and sensation, and brings the stomach into intimate and sympathetic relationship with the rest of the body.

Etiology of Gastric Neuroses.—*Age.*—Functional gastric disorders occur most commonly in young adults. They may, however, occur at any age, being frequently seen at or near the menopause.

Sex.—The neuroses unquestionably manifest themselves more frequently in women than in men, but the number of men suffering from gastric neuroses has in our experience rather increased in the past few years.

Nativity.—In this country the Jewish people seem especially predisposed to nervous disturbances of the stomach. Americans have for a number of years and with increasing frequency shown numerous departures from the normal gastric conditions. The stomach is one of the first organs to feel the effects of the wear and tear of life in this country.

Occupation.—Long hours, close application, with poor or artificial light, in improperly ventilated offices, are often causes of nervous disturbance. Monotony either in student or business life wearies the nervous system. Seamstresses and others, working steadily in a stooping posture, without fresh air or exercise, not infrequently develop stomach trouble. Any occupation requiring constant nervous strain

and excitement almost invariably interferes with gastric as well as with general innervation. Occupations requiring incessant talking or shouting, particularly when accompanied by physical activity or mental strain—as, for instance, auctioneering and schoolteaching—are prone to induce these affections. Mental strain, unusual and monotonous use of the special senses, simultaneously with physical strain, and unhygienic surroundings are the underlying harmful factors in occupations.

Mode of Living.—The struggle for social pre-eminence leads a large class of people into taxing social engagements, resulting in loss of sleep and composure, and neglect of healthful recreation. At the same time, these people are subjected to the exigencies of business or domestic strain, and are harassed by financial limitations; brain irritation and functional disturbances are the invariable results. Nerve tire follows in the wake of the social whirl, and stomachs suffering with exhausted innervation are made the recipients of a variety of delicious but dangerously inviting refreshments. Sufficient sleep and nerve rest are necessary for good innervation of the stomach. In those who have habitually followed an active out-of-door life and have recently adopted a sedentary existence, and who continue the habits acquired during the former more active life, the stomach becomes overtaxed and neuroses present themselves.

Reflex Causes of Gastric Disturbances.—One of the most prolific causes of functional gastric disturbances is eye-strain, and almost any neurosis may be induced by it. Gastric hyperæsthesia accompanied by hyperchlorhydria, to be followed later by more or less anæsthesia and achlorhydria, seems to bear a definite relationship to astigmatism of high degree. Without attempting to refer the condition to any special form of eye-strain, we have, nevertheless, been impressed with the frequency of the association of astigmatism and muscular imbalance with painful sensory conditions of the stomach, especially taking the form of distress and pain, accompanied by belching after meals—with a good appetite, but voluntary starvation through dread of pain induced by eating. These cases suffer for years, and are made rather worse than better by restricted diet.

Pelvic disease in women is also a fruitful source of reflex gastric disturbance. The correction of uterine displacement, especially retroversion, and ovarian disorders sometimes results in the disappearance or alleviation of the gastric affection. Other sources of reflex disturbance are occasionally to be found in abnormal conditions of the nose and throat, genito-urinary tract, rectum, and other parts. Floating kidney and enteroptosis are well known causes of gastric symptoms, some of which may be referred to disturbance of innervation.

Finally, gastric disturbances are extremely common in neurasthenia and hysteria. It is sometimes difficult to draw a sharp distinction between these conditions, but for clinical purposes it suffices to recognize the fact that the gastric condition is simply a part of the symptom complex, and that treatment, if it is to be successful, should be directed to the general nervous system, although sometimes much may be accomplished by local treatment of the stomach.

Acute and chronic toxæmias not infrequently give rise to functional disturbance. Influenza is a good example of the acute form, although

other infectious diseases in this way give rise to gastric disorders. The chronic forms may be illustrated by the dyscrasias of so-called lithæmia, gout, chronic nephritis, or renal insufficiency independent of organic disease of the kidneys, rheumatism, and diabetes. Some cases of stomach trouble may be traced to masturbation and to sexual excesses. Overtaxing the stomach is another common cause, and often results from hurried and bountiful eating when the nervous system is already tired. The heavy, indigestible lunches indulged in during business hours are responsible for many rebellions on the part of the stomach.

The gastric neuroses may be divided into those seemingly due to irritation or stimulation of the nerves of the stomach and those due to depression.

The neuroses are considered under four headings—viz: those of secretion, sensation, motion, and absorption.

Disturbances of Secretion.

HYPERCHLORHYDRIA.

When free hydrochloric acid is present in the stomach during digestion in quantities over .24 per cent., the condition is called hyperchlorhydria, which should not be confounded with supersecretion (Reichmann's disease), a term referring to the continuous secretion of gastric juice without the presence of food; nor should it be confused with superacidity, a condition in which the total acidity is raised above normal, but which acidity may be due to organic acids with or without free hydrochloric acid.

Jaworski found hyperchlorhydria in 115 of 121 cases of supersecretion; Ewald found it in only 45 of more than 1000 patients. Some observers take the ground that so-called supersecretion occurs in the majority of healthy stomachs. Martius found from .4 per cent. to .5 per cent. free hydrochloric acid in 8 cases thirteen hours after the last meal, and he holds that constant secretion of hydrochloric acid is not an abnormal occurrence. In many cases we have found free hydrochloric acid present in the empty stomach, but in all there were either symptoms of gastric irritation or hyperchlorhydria was present during digestion. Hayem believes that in hyperchlorhydria there frequently exists a mucous gastritis—a position that seems inconsistent with our fixed views of pathology, as it has been determined that inflammation of an organ depresses rather than increases its functional activity. In this connection it is interesting to note that Einhorn has found during life a proliferation of the secretory glands of the stomach associated with hyperchlorhydria—a condition that might be expected where there is excessive functional activity.

Symptoms.—While food is present in considerable quantities, the symptoms are not prominent, but usually appear from two to four hours after meals, and consist of gnawing or burning pain with eructation. Sometimes these sensations in the epigastrium are accompanied by soreness that is aggravated by forcible voluntary contraction of the abdominal muscles and tenderness upon pressure, occasionally sharply localized in the epigastrium a little to the right of the median line, as in ulcer. In some cases the gastric distress comes on during the night. Nausea

is not a constant accompaniment of the pain, but in some cases it occurs and persists until vomiting is induced. The patients complain that the matter vomited sets the teeth on edge; it usually consists of a very sour fluid, often having a greenish tint, with perhaps a few food fragments present, and relief sometimes follows the vomiting. Many of these patients learn to relieve themselves by drinking copiously of hot water and then exciting vomiting. Sodium bicarbonate is a favorite household remedy, and patients not infrequently give a history of having taken pounds of it during their suffering. Food generally gives temporary relief, especially nitrogenous foods and milk, while starches, fruits, acids, and highly seasoned articles of diet as a rule aggravate the symptoms.

Diagnosis.—If in hyperchlorhydria the stomach contents should be examined after a test meal, it will be found to contain more than the proper percentage of free HCl. In one hour after Ewald's test breakfast the total acidity is usually between 60 and 70 per cent.; later the total acidity increases, and free hydrochloric acid rises above the normal point. Repeated experiences lead us to conclude that even in the absence of the latter event, with an excessive total acidity not dependent upon organic acids, hyperchlorhydria should be suspected. In the presence of meat or egg-albumin more hydrochloric acid is combined, and thereafter does not appear free in as high percentage, nor is the total acidity so high—a fact affording valuable suggestions as to treatment.

The biuret reaction is usually present, and starch digestion is suspended. The exclusion of gastric ulcer in these cases is not always easy. The secretory condition is that which usually obtains in ulcer, and if the pain is paroxysmal and very severe, the case should be treated as if ulcer were present. The pain in ulcer, however, is usually aggravated by food, whereas in hyperchlorhydria comfort is restored for a short time after eating. The neurotic state may be present in either affection, but the strictly localized pain and tenderness, and the gastrorrhagia of ulcer are important differential points.

Treatment.—If the pain is severe and persistent, an absolute milk diet for a few days is advisable. Six or eight ounces of milk may be given every two or three hours, about two quarts being taken during the day. Sometimes hot milk is better borne than cold, and it should be drank slowly. Often this absolute change in diet alone is sufficient to give relief. When the case shows improvement the dietary may be enlarged, and all forms of fresh meats, preferably beef and mutton, are allowable; but meat and milk should not be taken at the same meal. Although less satisfactory, fowl and varieties of fish not too oily may be eaten occasionally. Salt meats should be excluded, as it is desirable to restrict the ingestion of sodium chloride. Starches should be given, at first solely in the form of stale bread, toasted at times to avoid monotony, zwieback, and the crust of rolls; these should be thoroughly masticated and not washed down with fluids. Eggs are usually well borne, and should be taken raw or very soft boiled [1] or soft poached. A very good plan for the day as regards diet is the following:

[1] A pint bowl filled with boiling water should be set upon a table; in this place an unbroken egg of medium size, and allow it to stand for ten minutes, when the white and

Breakfast.—Soft boiled or "coddled" eggs, stale bread, or stale rolls warmed over, weak tea or coffee with cream and a moderate amount of sugar. In the middle of the forenoon a glass of hot milk should be sipped.

Luncheon.—This should be light, consisting of stale bread or zwieback, weak tea, and a pint of hot milk. Effervescing table waters should be avoided. In the middle of the afternoon a glass of milk may be taken.

Dinner.—This meal should be abundant and slowly eaten. A period of rest should precede the meal and relaxation should follow it. Porterhouse steak, roast beef, or mutton roasted or boiled, stale bread, and a small cup of coffee if desired. After dinner water should be drank freely. Between ten and eleven o'clock at night a glass of hot milk should be taken. This programme may be modified as the patient improves. For instance, a raw egg may be substituted for the milk between meals; broiled bacon may be added to the eggs for breakfast, and baked potatoes, spinach, and other boiled salad, or greens may be added to the dinner. Condiments and zests are objectionable. Another, and in some cases the best, plan of diet is the "Hamburger" steak without herbs, or the so-called "meat balls," of which a proper amount should be taken every three hours and followed by large draughts of hot water. We have seen patients who did best when restricted to uncooked eggs given every hour or two for several days.

Alkalies and sedative remedies are indicated, and a very valuable combination that we have used for many years, and call the "gastric sedative," is prescribed as follows:

℞. Cerii oxalatis, ʒij;
Bismuthi subcarbonatis, ʒiv;
Magnesii carbonatis levis, ℥j.—M.
Sig. Even teaspoonful stirred in water in the middle of the forenoon, middle of the afternoon, and at bedtime.

This combination serves admirably to neutralize the excess of acid and soothe the irritated and perhaps congested gastric mucosa. Sometimes it acts as a cathartic, which is desirable, but if its action in that way is too pronounced, creta præparata may be added or substituted for the magnesium. On the other hand, if three doses a day are not sufficient to afford relief, particularly when the bowels are not loose, it may be given every two or three hours. If gastric flatulency is pronounced, two to four drachms of charcoal may be added to the prescription. Sodium bicarbonate in half-drachm or one-drachm doses in hot water very often gives relief by lowering the acidity, but its effect is evanescent and its continued use is undesirable in this affection. The potassium salts, especially the bicarbonate, the tartrate, and the citrate, in sufficient dosage and in solution with eucalyptol water or chloroform water, sometimes serve very well as direct alkalies. In some cases great benefit attends the administration of ichthyol: from two to five minims enclosed in capsules should be given every three to four hours.

the yolk will be slightly but equally cooked through, and the undesirable solid coagulation of the white is avoided.

Atropine sulphate has been recommended to diminish the secretion of hydrochloric acid, and we have used it with good effect, although it sometimes interferes with salivary secretion to such an extent as to render it undesirable. Hydrocyanic acid, chloroform, cocaine hydrochlorate, spirits of ether, camphor water, and a number of other drugs may be used occasionally, but are comparatively ineffectual. In case the stomach contains a large quantity of very acid contents consisting of gastric juice and food or of gastric juice alone, as in supersecretion, lavage gives the quickest temporary relief. The water used for lavage should be as hot as tolerable, but not hotter than the hand will comfortably bear. After the stomach is washed clean it is a good plan to introduce through the stomach tube and allow to remain in the stomach from two to four ounces of slippery elm water, linseed tea, or other mucilaginous fluid holding bismuth subcarbonate in suspension. Sometimes the menthol spray is useful in hyperchlorhydria. The local effect of menthol and its oily vehicle diminishes the secretory activity of the peptic glands.

The treatment of the condition underlying the neurotic state is extremely important, and is necessary for a complete cure. It involves the removal, if possible, of the cause, or at least some modification of it should be effected. This matter will be considered with the general treatment of neuroses.

HYPOCHLORHYDRIA.

Hypochlorhydria signifies a condition in which free hydrochloric acid is present in quantities below .14 per cent. at a time when it ought to be present in normal amount.

Etiology.—Causes depressing the secretory nerves induce this condition. We have not yet learned why from apparently like causes gastric secretion is stimulated in one person and reduced in another. At first this disturbance irregularly manifests itself; in other words, one day hydrochloric acid may be found in normal quantities, while the next day it is present only in traces or not at all, and if the neurosis persists upon every examination of the stomach free hydrochloric acid will be found absent, and this may go on until achylia gastrica is gradually established.

Achlorhydria signifies the absence of hydrochloric acid, and is simply a further step in the secretory change which commences as hypochlorhydria.

Symptoms.—This is a condition that may be present for years without giving rise to symptoms; in many cases we have found it present when relief was sought for headache, lassitude, nervousness, diarrhœa, or some other remote symptoms. Gastric symptoms are sometimes prominent, and they usually consist of a feeling of weight, distress, and fulness in the region of the stomach, with eructation soon after meals; nausea and vomiting may occur.

Diagnosis.—This condition is differentiated from chronic catarrhal gastritis by the presence of a sufficient quantity of pepsin and the lab ferment. In catarrhal gastritis lavage shows that the stomach contains an excess of ropy mucus, holding food fragments in its meshes. Car-

cinoma may be excluded by the absence of a manifest tumor, dilatation, food stagnation, emaciation, and by the history and gastric chemistry. Lactic acid may be present but only in small amount, and that, as a rule, depending upon preformed lactic acid in the ingesta. The stomach contents may appear well digested, and when combined hydrochloric acid is present the proteoses are abundant. Little or no free hydrochloric acid is present; acetic and butyric acid fermentations occur irregularly, being most marked when the patient is fatigued and when gastric motion is thereby depressed; indicanuria is frequently present.

Treatment.—Nitrogenous foods should not be used as freely as in hyperchlorhydria; some clinicians decidedly limit the use of albuminoids in this condition, but these foods may be allowed once daily.

Starches may be taken liberally, provided they are properly cooked, the best forms of such food being stale bread, zwieback, toast, crust of rolls, and mealy baked potatoes; soggy, half-cooked starchy foods should not be eaten; cooked, succulent vegetables are admissible in some cases. Plenty of salt may be eaten; condiments may also be used quite freely; ginger-ale serves as a useful beverage. The intragastric application of the interrupted current stimulates and tones the secretory nerves, exciting the secretion of hydrochloric acid; the continuous current is also indicated, especially in cases of gastralgia and irregular secretion. Einhorn and the writer have shown that either of these electrical currents applied by the direct method excites hydrochloric acid secretion, and such secretion may be excited when it fails to appear from the stimulation of food or the mere presence of the stomach tube. Frequently these cases present hyperlithuria, and alkalies exhibited before meals are followed by some relief and also by a diminution of the indicanuria.

Hydrochloric acid after meals is an excellent remedy in some of these cases, but does not seem to give the signal relief that is often noticed in cases of subacute or chronic catarrhal gastritis. If, however, fermentation is present, hydrochloric acid diminishes flatulency and restores gastric comfort. Nux vomica before meals is one of the best remedies at our command in this affection, probably owing to its tonic effects upon depressed innervation; occasionally this drug alone gives comfort and restores hydrochloric acid secretion. For further treatment of this condition see the general treatment of the neuroses.

ACHYLIA GASTRICA.

Definition.—We adopt the term achylia gastrica, as applied by Einhorn, to designate a condition of the stomach in which no gastric juice is secreted and therefore no proteolysis occurs. We have elsewhere described the condition under the caption "Gastric Anacidity." Ewald refers to it as resulting from anadenia ventriculi, or atrophy of the gastric glands.

Etiology.—Although it may manifest itself as a strictly nervous disturbance of the secretory function, unquestionably most cases of this affection are associated with atrophy of the gastric glands. Considerable discussion has arisen as to the nature of this atrophy, and most writers have attributed the degeneration to some form of chronic gas-

tritis. The prolonged study of cases leads us to the conclusion that some other factor is at work besides inflammation—first, because chronic gastritis continuing for years rarely leads to complete suppression of gastric secretion; and second, because we have studied cases of achylia gastrica, in some instances observing the development from a transient state into a condition in which secretion was persistently absent, without any evidence of gastritis. In fact, we believe that this peculiar disease begins as a functional disorder, and that from continued disease there occurs atrophy of the gastric tubules in which morbid process inflammation plays no part. In the absence of gastric secretion and in the presence of degenerating glands it is natural and easy for inflammatory changes to supervene, and in a proportion of cases this actually occurs. The most remarkable feature is that gastritis does not occur more frequently. The most important etiologic factors would seem, then, to reside in the causes of functional disturbance, and of these one stands out more prominently than all others, that cause being an aggravated eye-strain. This fact particularly applies to that group of cases in which a too active gastro-intestinal peristalsis is associated with the suppression of secretion resulting in a chronic lienteric diarrhœa. We have elsewhere described a group of 12 cases in all of which marked asymmetrical astigmatism or anisometropia was present, and in those cases seen early, before atrophy was believed to have commenced, marked benefit resulted from correction of the ocular error, and in some cases a complete cure was obtained without other treatment. Since reporting these cases a still larger number have been studied, and the factor of eye-strain has been invariably present. The affection is most insidious in its development, has periods of quiescence followed by active progress, and often is unaccompanied by gastric symptoms. Ultimately, however, these occur, but are generally the result of motor disturbance; that is to say, there is greatly increased or decreased gastric motility.

Pathological Anatomy.—Based on a clinical study, it is presumed that no anatomical changes are to be found in the early history of this affection. Subsequently there appears atrophy of the gastric tubules following absence of functional activity. There are reasons to suppose that this does not occur uniformly throughout the gastric mucosa, but that some areas remain practically intact, while others have advanced in degeneration. Some observations recently made by Einhorn confirm this view. He made sections from fragments of the mucous membrane found present in the water withdrawn during lavage, and from examination of these found that some showed a perfectly normal glandular structure, while others showed complete atrophy of the tubules. In one case a disappearance of the glands was demonstrated, and afterward there was found a fragment showing normal, undegenerated structure. When inflammatory changes occur, they are believed to conform to the ordinary picture of chronic catarrhal gastritis hereafter described.

Symptoms.—In some cases no gastric symptoms are present, and it is only by direct examination of the stomach that the condition is discovered. In other cases gastric flatulency is pronounced, and a sense of weight, fulness, and distress may be felt after meals. The appetite

is usually good, or may be exaggerated, unless the condition is associated with gastralgia, during an attack of which there is usually anorexia. Gastralgia is not an infrequent accompaniment of this affection, and there are also often present other manifestations of a neurotic character, such as hiccough, vomiting, hyperæsthesia, and insomnia. It will be observed that the symptoms are those denoting functional disorder, and very rarely, almost never in early cases, are they characteristic of inflammatory conditions of the mucosa. The symptoms referable to the stomach seem to bear a definite relation to its propulsive power, as it may be noted that distress, nausea, and vomiting supervene when food retention is prolonged. Constipation may be present, but is not as common as diarrhœa, which latter symptom often assumes some prominence, occurring, as it does, in a lienteric form after meals. In some of our cases diarrhœa was the most marked symptom. The remote manifestations of this affection are of considerable interest and importance, including, in some instances, profound anæmia with a cachectic appearance, and in others a painful condition of the joints, accompanied by roughening of the synovial surfaces, proliferation of the sero-fibrous structures, synovial effusion, swelling, stiffness, and disability. In one of our cases the hip-, elbow-, and shoulder-joints were extremely painful, so much so that the patient had been kept awake many nights, and there was extensive muscular atrophy, the patient being unable to raise his arm or leg. He was greatly emaciated; food remained twelve or more hours in the stomach; diarrhœa existed to the extent of from four to eight movements a day; the blood was much reduced; walking was performed in a slow, shuffling manner with the body bent forward, and was very distressing; the pulse was feeble, and death seemed imminent. Steady improvement took place, however, under lavage, intragastric faradization, and large doses of hydrochloric acid, pepsin, and strychnine. At the present writing the man is working a market garden and is fairly well, though gastric digestion has not reappeared and it is still necessary to continue the medicines.

Diagnosis.—The gastric contents after the Ewald test breakfast is usually either neutral or has a very low acidity, from 2 to 5; the food is little changed, being simply water-soaked; free and combined HCl is absent; lactic acid may be present in traces; fermentation acids are absent; no syntonin is found; no proteoses nor peptones are present; therefore the biuret reaction is negative; rennet ferment and rennet zymogen are absent; starch digestion proceeds, provided the albuminoid covering of the granules is sufficiently broken or digested to allow salivary action. The absence of bound HCl is shown by the large amount of the acid that it is necessary to add to the contents, filtered or unfiltered, before it appears free. The absence of pepsin is shown by the total lack of digestive action of the filtrate after the addition of a suitable quantity of HCl. Rennet ferment and zymogen are proved to be absent by the failure of the filtrate when properly treated with calcium chloride to coagulate milk.

In order to determine whether or not total absence of secretion exists the method of Javorski may be employed. It is carried out in the following manner: 200 c.c. of decinormal HCl are introduced in the morning into the empty stomach, previously cleaned, and in half an

hour it is withdrawn. The acidity of its filtrate is ascertained by decinormal sodium hydrate solution, and a small piece of egg albumin is used to test its digestive activity. If no digestion occurs, it is evident that no pepsin is present, and it is therefore apparent that its proenzyme was not formed in the stomach, probably because of complete atrophy of the tubules, else the HCl solution would have liberated it. In some cases of achylia gastrica the employment of this method shows a small degree of latent secretory activity.

Prognosis.—This condition may exist for years without failure of nutrition, provided the motor power of the stomach remains sufficient and intestinal digestion compensates for the lack of gastric function. Even when anæmia, loss of flesh and strength, diarrhœa, or the joint affection before mentioned become manifest, health may occasionally be restored by appropriate treatment. In the majority of cases improvement, but not cure, may be expected. There are instances of such marked deterioration of the general health that, though temporary improvement may be brought about, vitality ultimately fails, and death from exhaustion or some intercurrent affection may supervene. In some instances of death from pernicious anæmia, atrophy of the gastric mucosa, having been found present, has been considered causative of the disease (Flint, Henry and Osler, Ewald, Kinnicutt, and others). It may be said in reference to this matter that we have found pronounced secondary anæmias in some of our cases, but in none has the blood shown the pernicious type except in those associated with malignant disease, and recent post-mortems in those dying of pernicious anæmia have shown no atrophy of the gastric mucous membrane, while in others in which atrophy was discovered pernicious anæmia had not existed.

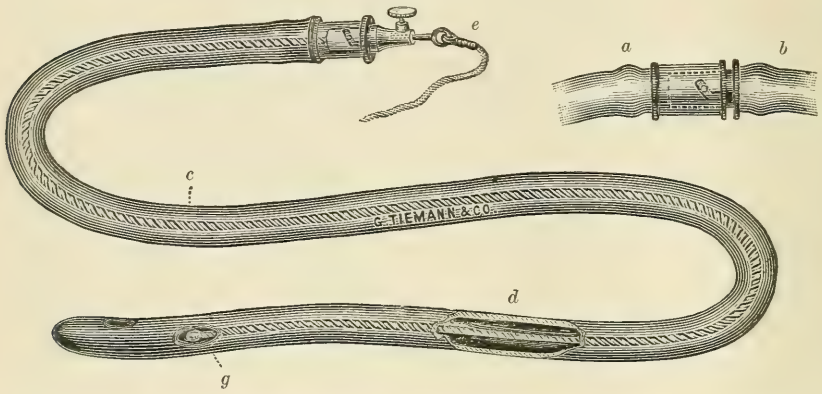
Treatment.—The main objects of treatment are—first, to re-establish gastric secretion if possible; second, to stimulate the propulsive power of the stomach if it is deficient; third, to quiet excessive gastro-intestinal peristalsis when present; and fourth, to combat the results of the disease, the chief of which are the anæmia and, in a proportion of cases, joint affection.

As a preliminary means the eyes should be carefully corrected. Next attention should be directed to the local treatment of the stomach. The establishment of gastric secretion and the stimulation of the motor function are both subserved by lavage with intragastric faradization and the administration of nux vomica. Lavage should not be practised too frequently, and may be discontinued when the motor power improves. Löwenthal recommends the use of a 0.6 per cent. solution of sodium chloride at a temperature of 104° F. for lavage in these cases, and we also use a weak solution of Carlsbad salts. Electricity may be employed with advantage three times a week, or even more frequently, without the withdrawal of the gastric contents, so that the patient shall not be robbed of nutriment. The faradic current should be used for five or ten minutes at each sitting, one pole being in the stomach, into which about 150 c.c. of a weak saline solution is introduced before treatment, and the other pole placed upon the epigastrium or upon the dorsal spine. The galvanic current may also be used with advantage with the positive electrode inside the stomach and the negative upon the

spine or epigastrium. The continuous current is especially advised when gastralgia is present.

To assist gastric digestion from fifteen to thirty drops of dilute hydrochloric acid or the equivalent of the stronger acid should be administered after meals in repeated doses, sometimes combined with

FIG. 1.



Stockton's gastric electrode: *d*, stomach-tube; *a*, rubber tubing; *c*, first steel tube; *b*, second steel tube, coupled; *e*, electrode *in situ*, forming a plug to first steel tube (manufactured by George Tiemann & Co.).

pepsin. The antiseptic influence of HCl in these cases may be of some importance, although there is a notable absence of fermentative changes, even when motility is impaired, such as occur in gastrectasia with pyloric stenosis or in many cases of catarrhal gastritis with atony in which the secretory function is fairly active, though hypochlorhydria may exist. Large doses of HCl are administered before meals in this affection by some clinicians.

Other digestants, such as papain, extract of pancreas, taka-diastase and extract of malt, may be used. Excessive peristalsis with which diarrhœa is associated is usually diminished or controlled by lavage with hot water and the administration of HCl. If these measures are insufficient, colon-flushing with hot boric acid solution or a solution of tannic acid one grain to the ounce may prove effectual, or bismuth subgallate may be given by the mouth. The fluid extract of coto bark in doses of ten or fifteen drops, or the fluid extract of guarana in half dram or dram doses, often gives satisfactory results. One-minim doses of Fowler's solution in an ounce of camphor water just before meals is often successful, and if the condition is urgent five drops of the tincture of opium may be added. Absolute rest in bed for a few days may be occasionally advisable. Anæmia usually improves without special medication, particularly when the patient lives out of doors a good deal and has the advantages accruing from sunlight, exercise, and hydrotherapy; but in some instances, notably in those with diarrhœa, tr. ferri chloridi, in fifteen- or twenty-minim doses, or a like amount of a solution of liquor ferri nitratis, serves a good purpose, owing perhaps, in a measure, to the astringent properties. Arsenic is also a valuable drug in this connection.

The joint affection is generally benefited by the treatment of the stomach, but sometimes it is advisable to use the galvanic electrical current upon the joints and the interrupted current for the weak and atrophied muscles. The static spray and sparks also give marked relief in some cases. These measures, with massage and hydrotherapy, are occasionally followed by distinct improvement, though too often the affection remains intractable to treatment.

Einhorn advises that the diet should consist largely of starchy foods —if practicable thoroughly dextrinized, finely divided, and thoroughly masticated, so that the cellulose covering of the starch granule may be broken, thus assisting the action of the ptyalin. We advise albuminoids at one meal of the day, as they will be digested in the small intestine. In the absence of catarrhal gastritis condiments may be taken, and salt should be freely used. The succulent fruits, oranges, grape-fruit, and lemons, are permitted at the meal when meats are taken. Rich puddings and pastries should be interdicted, while plain puddings, such as rice, sago, tapioca, and corn starch, may be allowed. Milk, perhaps peptonized, eggs, tender meats, stale bread, zwieback, salt and fresh fish, mealy baked or properly boiled potatoes and other vegetables, excluding those having too much cellulose, may be allowed. As beverages carbonated waters, lime-juice, acid phosphate, ginger ale, tea, coffee, and cocoa may be taken. Rhine wine, claret, Burgundy, sherry, and other wines should not be allowed, as they inhibit starch digestion in the stomach (Chittenden and Mendel). If the motor power of the stomach is unimpaired and if no diarrhœa is present, there is no need for prescribing a strict diet, as a wide mixed diet may be well cared for by intestinal digestion.

NEUROSES OF THE STOMACH.

Sensory Neuroses.

Hyperæsthesia.—Definition.—An over-sensitive and unstable condition of the sensory innervation of the stomach.

Etiology.—Hysteria and neurasthenia are often accompanied by gastric hyperæsthesia, the latter being a part of the general disturbance of the nervous equilibrium, while idiosyncrasy is the causative factor in some cases. It may accompany or follow acute diseases like influenza, or be initiated by nervous shock or strain; indeed, almost any of the causes of gastric neuroses may operate to induce this condition.

Symptoms.—These may vary from the most trifling discomfort after meals to severe pain or almost continuous distress. The irritability of the stomach may render it intolerant of food or water even in small quantities. It is difficult to separate hyperæsthesia and consider it as an entity, for the reason that it may play a part in any of the irritative disturbances. A very common illustration of this affection is observed in cases of pronounced neurasthenia in women, persisting for many years, and allowing not a mouthful of food to enter the stomach with-

out exciting so much distress that these patients bitterly complain that they never would eat were it not a positive necessity. All medicines are objected to because they cause distress, even tablet triturates of sugar of milk being complained of.

Diagnosis.—This is made only by excluding organic disease of the stomach and adjacent organs, and, as far as possible, other functional disturbances.

Treatment.—The general principles governing the treatment of the neuroses should be borne in mind. The special indications include the use of the galvanic current, the positive pole within the stomach, two or three times a week for five or ten minutes at each sitting, preceded by a hot stomach douche, while cerium oxalate, ichthyol, menthol, cocaine, hydrocyanic acid, chloroform, carbolic acid, chloral hydrate, or other local sedatives may be administered, ofttimes with benefit, by means of the spray. The diet should be nutritious, but not stimulating.

Gastralgia.—The term gastralgia, unqualified, signifies pain in the stomach. Essential gastralgia or neuro-gastralgia designates extremely severe paroxysmal pain in the stomach not resulting from organic disease. This occurs especially in neurasthenic and hysterical individuals. It may appear at almost any age, but is most common in adult females. E. W. Saunders of St. Louis observed 4 cases of gastralgia in children three, four, and five years old which were entirely cured by operation for adherent prepuce. Sometimes it occurs in men as well as in women of phlegmatic rather than nervous temperament, and in whom one would not suspect neurasthenia. Toxæmias, such as lithæmia or syphilis, may cause neuralgia of the stomach, as they so frequently cause neuralgia in other parts of the body. Given the predisposing nervous and constitutional conditions, the paroxysms are often excited by overtaxing the stomach with irritating food, or by mental strain, grief, worry, sexual excess, menstruation, excessive fatigue, or any circumstance liable to disturb nervous equilibrium. In some cases it is difficult to say what the exciting cause really is, and especially is this true in those having periodical paroxysms resembling attacks of migraine. We have observed a case in a business man who has for a number of years had repeated attacks of gastralgia while attending to business, but has never had an attack while away from home.

Symptoms.—The pain is usually paroxysmal, beginning and ending suddenly in most cases; it is variously described as gnawing, tearing, burning, cutting, or boring, and is located in the epigastrium. It may radiate to either side, downward, upward, or through to the back. Its duration may be from a few minutes to many hours or even days. In some cases it occurs with tolerable regularity, while in others its recurrence is notably irregular. It may come once a year or every few days. It seems to bear but slight, if any, relation to the ingestion of food, excepting in those cases in which it is excited by overtaxing a tired stomach with an abundance of food that is irritating. Often it supervenes in the night; in some of our cases paroxysms almost invariably appeared between two and four o'clock in the morning. Other symptoms, such as vomiting, salivation, belching, or hiccough, often accompany gastralgia. When vomiting occurs it is usually after pain has been present for some hours, and the emptying of the stomach sometimes

affords relief. Often the expression denotes excitement and anxiety; the body may be bathed in perspiration, while the extremities are cold, the hands shake, the voice is tremulous, and the patient tosses about with moans and cries; the pulse is tense and frequent, or sometimes infrequent; the urine is pale and copious during the attack, while later it is scanty, high colored, and hyperlithic. Following the attack there are often depression, headache, and weak circulation.

Diagnosis.—Other painful conditions are likely to be mistaken for gastralgia. One of these is gastric ulcer, which may be recognized by localized tenderness and pain, made worse by eating and by hæmatemesis. Carcinoma may be excluded by the age, history, gastric chemistry, tumor, and cachexia belonging to this affection. The pain is often attributed to biliary colic, which may be excluded by the absence of jaundice and the absence of calculi in the stools. Besides, the pain in gastralgia is much more easily controlled by anodynes than is that of biliary colic. The referred pain of renal colic may also be mistaken for essential gastralgia. Intercostal neuralgia may be recognized by the presence of Valleix's points. Angina pectoris is excluded by the history and by the fact that the pain does not radiate down the left arm. There may be no arterial change and no heart murmur during the attack. The gastric crises of locomotor ataxia may also be excluded by the absence of other symptoms of tabes dorsalis. Sometimes, however, in latent locomotor ataxia paroxysms of gastralgia may be the only manifestation of the disease. Severe gastric pain sometimes occurs in disseminated sclerosis, spinal curvature, chronic spinal meningitis, etc.; therefore the nervous system should always be examined.

Pancreatitis, subphrenic abscess, appendicitis, floating kidney, or perinephritic abscess may give rise to pain simulating gastralgia.

Treatment.—The paroxysm of gastralgia is often controlled by lavage with water at a temperature of 105° F., or the galvanic current may be applied, the positive pole being used internally and the negative over the epigastrium or the dorsal spine. The sitting should last from five to ten minutes, and the strength of the current should be from five to twenty milliampères. After the lavage is finished and the stomach is clean, from thirty to sixty grains of bismuth subcarbonate or subnitrate, suspended in about four ounces of mucilage of tragacanth, acacia, or althæa, may be introduced into the stomach or menthol spray may be used internally. In case no stomach tube is at hand an emetic may be given, preferably one tenth of a grain of apomorphine hypodermically. Sometimes drinking copiously of hot water relieves the pain. The Scotch douche, consisting of the alternate application of hot and cold water to the epigastrium, occasionally eases the patient. In some cases the cold spinal douche, a full warm bath, or heat applied to the epigastrium may give relief. Rubefacients, such as mustard, applied along the dorsal spine and to the epigastrium, and dry cupping are of some use. Vibration applied either by the fingers of a skilful masseur or by the machine vibrator has been used with some success. Internally, the sedative combination of cerium oxalate, bismuth subcarbonate, and light magnesium carbonate, or cocaine, dilute hydrocyanic acid, menthol, spiritus etheris comp., or chloroform may be given. If the stomach is distended with gas, asafœtida, spirits of lavender, charcoal, oil of rosemary,

or oil of gaultheria may be administered. Sometimes drugs having a central action, such as quinine in a dose of ten or fifteen grains, or antipyrin, acetanilid, phenacetin, hyoscyamus, cannabis indica, or chloral hydrate, may ease or check the pain. Opium and its derivatives are most effectual, but should not be used unless absolutely necessary, owing to the danger of the easily formed opium habit; if necessary, morphine should be given subcutaneously, only by the physician. The vaso-dilators, such as nitro-glycerin, aromatic spirits of ammonia, amyl nitrite, or brandy, may cut short the attack. Chloroform or a mixture of oxygen and nitrous oxide may be inhaled until the pain ceases. Atropine, $\frac{1}{200}$ of a grain, with hyoscyamin sulphate or hyoscin hydrobromate, $\frac{1}{100}$ of a grain, may be given hypodermically. This combination is often of extraordinary value in controlling this as well as other severe neuralgias. Sometimes an enema of hot water or of the emulsion of asafœtida relieves the pain. If we are able to locate the point of reflex irritation—as, for instance, the uterus—soothing applications there applied may result in stopping the gastralgia. The treatment of the nervous conditions underlying the gastralgia is considered under the General Treatment of the Gastric Neuroses (p. 134).

Nausea.—The nausea here referred to is a neurosis due to external causes, such as grief or intense worry, or to reflex causes, such as abnormal conditions of the eyes, nose, pharynx, or tonsils; it may be the result of the pelvic reflex (pregnancy), and is a common symptom in neurasthenia and hysteria, being present sometimes for days without intermission, although perhaps not accompanied by vomiting. The stomach contents may be normal or some secretory disturbance may be associated with the nausea. That which seems to be wholly nervous nausea may depend upon gastro-intestinal toxæmia or lithæmia.

Treatment.—The treatment depends upon the cause. If the symptoms of neurasthenia are pronounced, valerianates, bromides, nitroglycerin, and diffusible stimulants may give relief. If the heart is strong, the administration of acetanilid, antipyrin, or phenacetin is occasionally followed by a subsidence of the nausea. If the urine is hyperlithic, alkalies exhibited before meals often cause a disappearance of the symptom in a few days. If constipation exists, calomel should be given, and may be followed by aloes, podophyllin, or salines. If there is low blood pressure and cerebral anæmia, digitalis and nux vomica and the cold spinal douche are followed by good results. Local gastric sedatives sometimes give relief, but are not as effectual as they are in inflammatory conditions of the stomach. Chloroform, cocaine, bismuth, cerium oxalate, hydrocyanic acid, or carbolic acid should be tried. Lavage with hot water usually gives temporary and, sometimes, permanent relief.

Anorexia.—This term signifies total lack of appetite, although it is used to denote various degrees of diminished appetite. Hunger is the expression not only of a state of the stomach, but of the ultimate cells of the body. The stomach may be empty for days, and still anorexia persist. Loss of appetite may be due to nervous depression or to overstimulation of the stomach. It usually accompanies nausea, and may persist after nausea ceases. It is a very common symptom of neurasthenia and hysteria, and may coexist with good digestion. It may be

temporary or continue for weeks or months, often coming and going irregularly. Occasionally it is associated with a disgust for food. Unsavory dishes, poor cooking, uninviting food may excite anorexia in a sensitive person, although there is a distinction between the lack of a desire for food and a dislike for certain dishes. The condition may persist until the patient loses flesh and strength, and in rare instances great emaciation results. We observed one case of traumatic neurosis in which death resulted from voluntary starvation, and no other cause of death was found post-mortem. It is not uncommon to meet patients who say they never experience hunger, but force themselves to eat, and, as these persons are well nourished, there is reason for thinking there is a good deal of exaggeration in their reports. Temporary anorexia may be caused by mental excitement or depression.

TREATMENT.—In the treatment of this affection abundance of fresh air, sunlight, and out-of-door exercise, with exhilarating games, are very useful, their influence upon the nervous system being perhaps the chief factor in restoring appetite. Nux vomica and arsenic are the most valuable drugs, although quassia, cinchona, gentian, condurango, chirata, orexin, valerianate of zinc, phosphide of zinc, or asafœtida may be tried. If gastric hyperæsthesia exists, sedatives, such as bromide of strontium, bismuth, cerium oxalate, or hydrocyanic acid, should be used.

Hyperorexia.—The term bulimia is used synonymously with hyperorexia, but a distinction may be drawn by saying that the former signifies a voracious appetite which is not appeased by anything but enormous quantities of food, if, indeed, it is satisfied at all (polyphagia), whereas the latter may be applied to a more moderate increase of the appetite. There is no criterion by which to govern every man's appetite, as each individual is a law unto himself in that respect. Some are satisfied and well nourished by small amounts of food, while some are never in good condition even though they possess large appetites and eat enormously. Marked hunger sometimes accompanies hyperchlorhydria, the patient feeling a gnawing desire for food two hours after a hearty meal; or it may appear without any apparent disturbance of the stomach whatever, being simply a manifestation of neurasthenia, hysteria, idiocy, or insanity.

Instances of acute bulimia are on record in which enormous quantities of food and drink were devoured in a short time, as in some interesting cases cited by Ewald. We have seen gluttons, including children, gorge themselves until they were obliged to vomit, and still they returned to eating.

The most common form of hyperorexia is that in which the patient eats frequently between meals. Some individuals carry food in their pockets and take frequent mouthfuls during the day. Some crave food in the night, and make a practice of either having a supply at the bedside or of getting up and cooking some savory dish between midnight and early morning—a matter that is exaggerated by habit. In order to establish a diagnosis of nervous hyperorexia, diabetes mellitus, anæmia, pregnancy, intestinal parasites, insanity, or gross disease of the nervous system should be excluded.

Mild and temporary increase of the appetite may be present in convalescence from acute illness, long, profuse hemorrhage, or profuse

diarrhœa. Disorders of the appetite probably have their origin in the central nervous system, although in some instances they may be traced to peripheral irritation. The existence of a hunger-centre in the medulla has been assumed, and is not improbable.

The TREATMENT should be addressed to the general nervous state, and at the same time the patient's will power should be exerted, as the condition may be partly habit and can be controlled by mental influence. Peripheral irritation should be removed if possible. It may be necessary in some instances to give opium or morphine, but these "two-edged swords" should be used cautiously, as neurotics are ever prone to fall from one habit into another.

Parorexia.—Parorexia signifies a desire for unusual articles of food, or for substances that cannot be called food, as slate-pencils and chalk. In rare instances this condition becomes a true psychosis in which the subjects eat disgusting and filthy substances with apparent relish.

Idiosyncrasies.—The untoward effects of certain articles of diet assume most interesting and perplexing phases, causing phenomena that may be local or remote. Some individuals cannot eat beefsteak, others cannot eat oysters without gastric discomfort, while potatoes, milk, eggs, parsnips, the different fruits, and many other ordinary articles of diet may each induce some form of stomach disturbance, such as pain, flatulency, nausea, vomiting, or diarrhœa, one or two things being usually singled out as offenders, while everything else agrees. The remote effects include pruritus, erythema, urticaria, cancrum oris, herpes labialis, angioneurotic œdema, asthma or hay fever, and other similar disturbances which may follow the ingestion of shellfish, pork, cheese, celery, strawberries, or other foods that are not disturbing to the great majority of mankind. These peculiarities on the part of certain individuals cannot all be explained by assuming that the gastric nerves are hyperæsthetic and therefore convey reflexes readily. The phenomena may be due to the absorption of certain principles in these foods which are to these individuals toxic and act through the blood upon the vasomotor and trophic nerves of distant parts.

Motor Neuroses.

Eructation.—Gastric flatulency with belching is one of the most common of the neuroses. When the stomach fills with gas and does not allow its escape the condition is termed pneumatosis. Nervous belching frequently accompanies neurasthenia and hysteria. We have seen it continue uninterruptedly for forty-eight hours in the case of a lady whose horses ran away, throwing her from her carriage, causing fracture of the tibia near the ankle. The belching was finally controlled by mistura asafœtidæ cum opio. Eructation is sometimes associated with relaxation of the cardia, and, even though the cardia has good tone, it relaxes to intragastric pressure before the pylorus does, owing to its being the weaker sphincter. The origin and composition of the gas is doubtful. In some organic diseases of the stomach fermentation results, and eructations then consist of hydrogen, nitrogen, and carbon dioxide. In the condition under consideration, however,

the gas is probably chiefly composed of air that has been swallowed, although it may be mixed with gases from the blood and intestine. Woods Hutchinson advances the suggestive hypothesis that in some forms of gastric flatulency we have an instance of a reversion to the respiratory function of the stomach. Federn announces that if a healthy individual in the dorsal decubitus practises deep inspiration without swallowing, the amount of air found in the stomach is perceptibly increased. In some cases belching proceeds from the œsophagus. We frequently fail to find the stomach distended with gas in nervous patients complaining of bloating and belching. The act of belching may take place in nervous persons without gas being raised. Gastric weight, fulness, distress, or pain may be complained of by those who are subject to eructation, and there is almost universal testimony that relief follows belching. Cardiac palpitation, fulness in the head, vertigo, blurring of the vision, and a feeling of suffocation are symptoms occasionally present with pneumatosis, which disappear or are very much diminished by free eructation.

TREATMENT.—Local gastric sedatives seem to check flatulency sometimes by quieting excessive or irregular peristalsis. Bismuth subcarbonate or subnitrate may be used alone or in combination with alkalies. Very finely powdered hardwood charcoal, as suggested by Leared, given in teaspoonful doses in wafer papers, affords temporary relief in almost all cases. The charcoal should be reignited in an iron capsule, bottled while hot, and kept carefully stoppered. Aqua chloroformi, if given freely, may exert some control. Emulsum asafœtidæ is one of the best remedies for nervous belching that we have at our command; it should be given in half-ounce doses three or four times a day. Its disagreeable odor is the chief objection to its use, but such decided relief is experienced that patients are soon willing to take it. The aromatic oils of rue, cinnamon, cloves, peppermint, rosemary, and valerian are sometimes useful, as also are capsicum and gentian. In deficient secretion hydrochloric acid should be given, as it prevents flatulency by its effect upon gastric motility as well as upon the chemical change of the food. If constipation coexists, rhubarb with senna or aloes should be employed. Lavage and gastric faradization should be resorted to if other means fail.

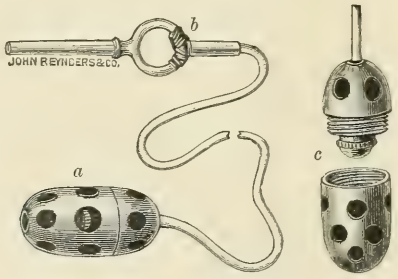
Regurgitation; Pyrosis; Heart-burn.—This is a condition in which the food rises involuntarily from the stomach into the œsophagus or mouth. It is a frequent symptom of organic disease of the stomach, such as catarrhal gastritis, and as a transient symptom is commonly seen when a healthy stomach is irritated by an improper meal. As a distinct neurosis, unaccompanied by any structural change, it is seen in neurasthenic and hysterical patients, being perhaps associated with, and somewhat dependent upon, gastric hyperæsthesia, with probable relaxation of the cardia. It occurs more commonly in women than in men, and usually follows the ingestion of food. Patients complain of the intense acidity of the regurgitated food, which, however, upon examination, is found to be that of normal stomach contents. Regurgitation frequently results in healthy individuals from accidental fermentation, but in those suffering from this neurosis the symptom occurs when the stomach contents is normal, although it is undoubtedly increased when

fermentative changes coexist. As a rule, when a small amount of food is regurgitated the nutrition of the patient is not appreciably impaired; on the other hand, food may be raised so frequently and persistently, and may be so copiously ejected, that weight and strength are quite rapidly lost, and the condition may even induce extreme weakness and emaciation. Sometimes regurgitation is largely a habit, and the patient becomes convinced that no meal will remain in his stomach; furthermore, abnormal sensory states are developed and a feeling of comfort follows the expulsion of food. In some hysterical cases the food is expelled from the œsophagus before it reaches the stomach, almost immediately after it is swallowed. In the diagnosis it is important to exclude the functional disturbance known as merycismus or rumination as well as œsophageal stricture, carcinoma, or benign stricture at the cardia, and gastrectasia with pyloric stenosis; these all being conditions interfering with the onward passage of the food.

Treatment.—In addition to the general treatment of the neuroses, regurgitation calls for a few special measures. Local sedatives often diminish the intragastric irritation, thereby lessening excessive gastric peristalsis and the subsequent relaxation of the cardia. Bismuth subnitrate or subcarbonate may be given suspended in mucilage of tragacanth. A pleasant preparation is offered by making a mucilage of tragacanth with chloroform or cherry-laurel water and thoroughly mixing the bismuth with it, making an emulsion of the consistency of cream, which may be given in teaspoonful doses immediately before eating. Owing to the hyperæsthesia of the gastric mucosa in this condition, the acidity of the stomach, even though it be normal, should be somewhat lessened by the administration of alkalies. Strychnine imparts tone to the muscular fibres of the cardia, and is sometimes effectual for the relief of this condition.

The intragastric use of the interrupted current through Einhorn's electrode is sometimes beneficial. It may be applied from five to eight

Fig. 2.



Einhorn's deglutible gastric electrode.

minutes two or three times a week, or every day for a short period if the case demands urgent measures.

Merycismus; Rumination.—This is a rare affection in which the food is voluntarily raised from the stomach into the mouth, when it is remasticated and again swallowed. It is literally "chewing the cud," and is in all probability a distinct neurosis, occurring in both

sexes and at any age, except, perhaps, infancy. Rumination may exist during most of a lifetime, while, on the other hand, it may be of short duration. In some cases separate articles of food can be raised at will, and patients aver that from a mixed meal they are able to raise this or that particular food some length of time after it has been eaten. The food is said not to have an unpleasant taste, but even in some cases a pleasant one. If this is true in any case some time after eating, it may be assumed that gastric digestion is partially or wholly suspended, else the food mass would be sour and bitter from free acid and peptone.

Merycismus should be distinguished from regurgitation. Both are associated with relaxation of the cardia, but merycismus is a voluntary performance. In some cases, post-mortem, the cardia has been found much dilated, and it is probably insufficient in most cases. The gastric chemistry may be normal, and no structural disease of the stomach exist; usually no depreciation of health results.

TREATMENT.—The chief remedial measure consists in emphatic instruction to the patient to swallow the food immediately without remasticating it, and to persistently endeavor to resist the desire to raise food. The intragastric electrode may be used, the faradic current being employed. Patients may be instructed to chew gum after meals or to hold a bit of licorice or some sialogogue in the mouth, or the emulsion of asafœtida may be given in half-ounce doses after meals, when the patient may find it very unpleasant to remasticate the food mixed with asafœtida, or the drug may have a controlling influence upon the nervous disturbance. Constitutional treatment should not be neglected.

Vomiting.—Vomiting is one of the most common of the neuroses, being seen most frequently in neurasthenic and hysterical women, although it is not uncommonly observed in men. It may occur at any age, but it usually supervenes between the twentieth and forty-fifth years; it is very apt to come on at the menopause; it results from reflex irritation in many cases; it may occur infrequently and cause but little loss of flesh, or it may be severe and persistent, causing pronounced emaciation, and in rare cases death may result. The pelvic organs are a very common source of reflex irritation, causing nervous vomiting, as there exists a very intimate connection between affections of the stomach and the pelvic organs in women, the vomiting of pregnancy being an illustration of this. Floating kidney and visceroptosis are also fruitful causes of this disturbance. Frequently eye-strain is the principal causative factor. In some cases it is very difficult to determine whether the disturbance is due to some reflex or toxæmia, as, for instance, uræmia. Certain it is that in some instances, apparently dependent upon malposition of the uterus, the vomiting is controlled best by eliminative measures, such as free catharsis and the induction of profuse diaphoresis, and in the vomiting of pregnancy hot-air baths are sometimes of signal service. In some cases all the food eaten is said to be rejected, but very little weight is found to have been lost even though the trouble has persisted for a considerable period. The stomach tube discloses plenty of food remaining in the stomach in these patients. Nausea is not constant, but may be marked and accom-

panied by salivation. Some persons subject to this affection learn by experience that certain articles of food cause them to vomit or certain combinations cannot be eaten, as, for instance, fruit and cream together, although either may be taken alone with impunity; they also learn to stop eating after a definite amount of food has been taken, one mouthful more causing disturbance. Vomiting may be accompanied by other nervous symptoms, as belching, cardiac palpitation, numbness of the hands or arms, or disturbance of vision. It is probable that a habit may be formed which enables the patient to vomit voluntarily in some instances. Sometimes the disturbance is paroxysmal, and everything that is swallowed is quickly rejected for a number of days.

Diagnosis.—The diagnosis involves the exclusion of diseases of the brain and cord or their coverings, structural affections of the stomach, the onset of infectious diseases, uræmia, and other well-known causes of vomiting.

Treatment.—For controlling an acute attack chloral and bromide per rectum are more effectual than remedies given by the mouth; fifteen or twenty grains of chloral and a drachm of potassium bromide in a mucilaginous vehicle should be given an adult by enema in one dose. Hyoscin hydrobromate or morphine may be given hypodermically; atropine may be tried combined with either of these. Carbonated water, ice-cold, or very hot water may quiet the stomach. Sometimes the passage of the stomach tube immediately checks an attack, and if not thorough lavage with hot water will be found to be the best measure for temporary relief, or the intragastric use of the positive continuous current may be tried. The nervines asafœtida, valerian, and sumbul may be employed. Nitroglycerin in small and oft-repeated doses is occasionally of great service. Local gastric sedatives are usually disappointing in their results, yet are sometimes unexpectedly successful. The list includes carbolic acid, cocaine, cerium oxalate in doses of 10 or 15 grains, the bismuth salts, chloroform water, and hydrocyanic acid. Of these, cocaine, cerium oxalate, and carbolic acid are most reliable, and it cannot be denied that they may to some extent have a central as well as local effect. Fasting is a time-honored and useful measure; it should be thoroughly carried out, and nothing whatever allowed in the stomach for from twenty-four to fifty-six hours.

Vomiting in Alcoholism.—The morning vomiting is commonly attributed to subacute gastritis, which, in fact, is sometimes the case; we are satisfied, however, that in the majority of instances the symptom is another expression of the unbalanced nervous system that causes the tremor, muscular inco-ordination, and other motor disturbances. While it would be unwise to disregard the structural changes or the other functional disorders of the stomach in alcoholism, it is nevertheless true that the greatest success in treatment is that directed toward the nervous system and that which is found to "steady" the patient generally. Among the remedies that are most successful for relief are the aromatic spirits of ammonia, Hoffman's anodyne, strychnine in full doses, atropine, cannabis indica, the bromides, chloral, and arsenic. Local stimulants are often of signal benefit, and one of these is capsicum. Gastric sedatives are rarely of use, which may be considered as evidence that gastritis is not present. The discontinuance of the habit is frequently

followed by cessation of the vomiting; on the other hand, the symptom is temporarily relieved by the taking of the "morning dram."

Peristaltic Unrest.—This is the opposite of atony. In some instances the stomach empties itself precipitately, especially when relaxation of the pylorus is present; in other cases the pylorus remains closed, and with a full stomach the peristalsis may be seen, by careful inspection of the epigastrium, in distinct waves lifting the abdominal walls and moving from the cardia toward the pylorus. We have frequently observed large and strong peristaltic waves of an over-full stomach with carcinomatous pyloric stenosis—a condition that should be differentiated from nervous unrest. Sometimes the peristalsis is reversed, the waves moving from the pylorus toward the cardia, or irregular waves may hurry one another, and finally settle in some point in tonic contraction, causing, perhaps, more or less pain. This constitutes a stomach colic, so called. Regurgitation and belching are common results of peristaltic restlessness, or diarrhœa may result from the food being hurried into the intestine.

TREATMENT.—Chloral and hyoscyamus may be given in small doses. Strontium bromide in ten- or twenty-grain doses before meals may be tried. If the stomach contents are superacid, sodium bicarbonate or the light magnesium carbonate, with or without bismuth, should be given an hour or two before meals. If stomach colic occurs, opium may be given in sufficient dosage. Special treatment is usually unnecessary, as the symptom disappears under the influence of measures directed toward accompanying gastric disturbances.

Atony.—This denotes a state of diminished muscular activity of the stomach resulting from causes operating to depress the nervous system. Atony may exist a long time without giving rise to any symptoms, but when it causes considerable delay in the onward passage of the food a sense of weight, fulness, and vague distress, with flatulency, usually supervenes. Many degrees of atony are met with. Patients present themselves one day with food in the stomach six or seven hours after its ingestion, while a few days later the same stomach is found empty after a like meal. In some cases gastrectasia results from atony; we have a number of cases in our record books in which the lower border of the stomach reached nearly four inches below the umbilicus when first examined. Sometimes hydrochloric acid is present in high percentage, as in the atonic superacid (Germain Sée) stomach; in other cases it is below normal or may be absent. Food stagnation, as a rule, is not as marked as in gastrectasia depending upon pyloric stenosis, but in a few cases we have found food present that was eaten several days before. Dilatation from atony may result in considerable loss of flesh. In one of our patients who was greatly emaciated the lower border of the stomach reached nearly the pubes. Under lavage and intragastric faradization he gained forty-five pounds in two months; food stagnation was at first very marked, but soon disappeared under treatment. Constipation is the rule, and atony of the colon a frequent accompaniment.

TREATMENT.—Lavage should not be practised too often; it is best employed at night, leaving the stomach empty until morning. Intragastric faradization is of signal benefit; the strength of the current

should be as great as can be comfortably borne by the patient, and the sittings should last from five to ten minutes. If hyperchlorhydria coexists, "the gastric sedative" is called for, whereas if hypo- or achlorhydria is found, hydrochloric acid should be administered in large doses after meals. Nux vomica or strychnine may be given in large doses, excepting in cases with hyperchlorhydria, and physostigma may be used as an adjuvant. Medical gymnastics and massage of the abdomen are useful in this condition. The diet should be carefully chosen; no coarse, indigestible foods should be taken; mastication should be slow and thorough, as it stimulates gastric motion; the stomach should not be overloaded at any time.

Relaxation of the Pylorus (Pyloric Incontinence).—This condition is probably present in cases of precipitate emptying of the stomach, as in lienteric diarrhœa resulting from a persistently patulous pylorus; in some cases the pylorus has been found dilated sufficiently to admit several fingers. Sometimes the stomach empties itself as early as an hour or two after a medium-sized meal.

We quote the following illustrative case from our records: Three hours after a test dinner the stomach was found empty; on the following day lavage was practised two hours after the same meal with a like result; on the third day the stomach was examined one hour after the meal, and again found empty; on the fourth day lavage was practised thirty minutes after the dinner, and the meal was present practically unchanged.

One of the most significant symptoms of pyloric insufficiency is the finding of bile in the stomach contents, and the stomach digestion in these cases somewhat resembles that found after a gastro-enterostomy has been done for relief of the pyloric stricture.

Treatment.—Faradization internally seems to offer the best results. It should be practised two or three times a week, preferably before a meal. Rest after meals is indicated. Strychnine may be given in ascending doses until the twenty-fifth or twentieth of a grain has been reached. Small doses of opium before meals have been found in some cases a necessary measure. The diet should be solid and moderately stimulating to the stomach from the addition of condiments to the food, as, for instance, cayenne pepper or preserved ginger. In some cases in which gastric peristalsis is proportionately greater than the pyloric contraction large doses of bismuth are beneficial.

Pyloric Spasm.—This occurs from intragastric irritation, such as superacidity, or it may be simply one form of irregular gastric movement. It may delay the usual emptying of the stomach for several hours, and thereby give rise to moderate dilatation. Sometimes peristaltic waves may be seen, especially if the stomach is well filled with food.

Treatment.—If the stomach contents show superacidity, the alkalies with gastric sedatives are indicated. If peristaltic waves are seen vainly working against the closed pylorus, the stomach should occasionally be emptied by lavage, and bismuth in some mucilaginous vehicle should be introduced into the stomach before the tube is removed. The diet should be plain, bland, and composed chiefly of milk with lime water or Vichy; zwieback, soft boiled, soft poached, or raw eggs.

Relaxation of the Cardia.—The symptoms of this condition usually consist in regurgitation and eructation; sometimes it is associated with rumination. The degree of relaxation that may exist is for the most part a matter of speculation, and it is more reasonable to suppose that, owing to lack of tone, the cardia relaxes to normal intragastric irritation and pressure, rather than that the cardiac orifice is actually patulous.

TREATMENT.—The treatment of this condition consists in reducing the acidity of the stomach contents and in the administration of nux vomica, physostigma, gentian, cinchona, or calumba to excite extra-muscular tone. Of these nux vomica is most useful. The intragastric application of the faradic current is indicated.

Spasm of the Cardia.—This condition is not uncommonly seen in hysteria, and may be tonic or clonic in character. In a pronounced case of this affection we observed spasm that continued uninterruptedly for two weeks. The patient was a girl eighteen years old, who gave a history of having had somewhat the same condition several years before, at which time she was fed through a tube for two weeks. We repeatedly endeavored to pass the flexible tube into the stomach without success. The patient maintained that she was unable to swallow food of any sort. Treatment addressed to her nervous state resulted in a gradual disappearance of the dysphagia, and finally in cure. In some cases the spasm is excited by emotion, and the patients suddenly find that they are unable to swallow food or drink. When retching is persistent and nothing is vomited, it is probable that spasm of the cardia prevents escape of the stomach contents. We have sometimes noticed marked contraction of the cardia upon the stomach tube, causing difficulty in withdrawing it; more commonly, however, it prevents the passage of the tube.

DIAGNOSIS.—In arriving at a diagnosis it is necessary to exclude organic stricture of the lower part of the œsophagus or of the cardia. This is done best by anæsthetizing the patient, when in a case of spasm the tube will enter the stomach without difficulty. If it is not practicable to use an anæsthetic, the age of the patient, the history of the illness, the onset and character of the symptoms, the nutrition and the appearance of the patient should be considered. Sometimes these general manifestations are more reliable than information gained by the use of the tube under anæsthesia, as illustrated in one of our cases, in which an increasing cardiac stenosis was associated with spasm that disappeared for several weeks after the introduction of the tube under anæsthesia. The diagnosis of spasmodic stricture was not complete, as the obstruction returned and the man eventually died of cancer of the cardia. If the tube enters a dilated œsophagus and withdraws food, it is probable that organic stricture exists. There are cases that baffle the skill of the best diagnosticians in that they present all the manifestations of malignant disease or organic stricture of the lower portion of the œsophagus or cardia, and yet, without either surgical intervention or medical treatment, the dysphagia and regurgitation diminish, the patients gain weight and strength, and remain in fairly good health for months or even years. We have recently observed two instances of this nature.

TREATMENT.—Sedatives acting upon the central nervous system are indicated, such as bromides, chloral, hyoscyamus, and morphine. The

continuous current may be used with the positive pole inside the œsophagus. If hysterical stigmata are manifest, the emulsion of asafœtida or the fluid extract of valerian may be given by enema. In case of obstinate spasm it may be necessary to practise gavage or rectal alimentation.

General Treatment of the Gastric Neuroses.—A gastric neurosis is the local expression of some constitutional state or nervous irritation arising outside of the stomach, and therefore any plan of therapeutics based on local treatment alone will ultimately meet with failure. Local measures are of the utmost value, however, in producing temporary relief, and recovery is retarded and sometimes prevented until such treatment is employed. The course should be sufficiently broad to include, besides local, such general measures as the individual case may require. As far as possible the cause or causes should be removed or modified, this being the most important part of the treatment. Therapeutic measures applied to the stomach directly may result in temporary relief, but in the majority of cases do not cure so long as causative elements are operative. For this reason the eyes should be examined and refractive errors corrected. Hyperopic astigmatism is the most common form of eye-strain met with in nervous affections of the stomach. Muscular errors are exceedingly aggravating, and constitute a fruitful source of reflex gastric disturbance, but in many instances heterophorias yield to proper correction of astigmatism. Compound hyperopic or mixed astigmatism, with irregular axes and perhaps anisometropia, is a very common form of brain- and nerve-disturbing eye-strain. Abnormal conditions of the pelvic organs, particularly in women, constitute another fruitful source of reflex gastric disturbance. "Brain-tire" should be relieved by rest and a change of scene. Such conditions are most commonly seen in the North toward the end of the winter, when men, exhausted by business strain and women by social excitement, are usually relieved by a stay at some Southern resort or by an ocean voyage. Some individuals seem benefited by the sea, while others do best in the mountains.

Improvement in the condition of the nervous system usually follows systematic muscular development, and in almost all forms of the gastric neuroses carefully prescribed exercise in the gymnasium or in the open air, especially the latter, is a necessary part of the treatment; those exercises accompanied by a certain amount of pleasurable excitement are to be preferred.

Floating kidney should be treated by *medical gymnastics*, a properly fitting pad and bandage, or, as a last resort, by nephrorrhaphy. Disorders of the male genitalia should receive proper treatment. Lithæmic patients should be directed to exercise in the open air and sunlight, and should be instructed to drink plentifully of pure water free from mineral constituents, save, perhaps, lithia, which in some instances accomplishes good. If the gastric chemistry allows it, a milk diet may be prescribed for a few days, although some lithæmic individuals cannot drink milk without inducing hepatic torpor, obstinate constipation, headache, and sometimes nausea. Alkalies, such as potassium acetate, potassium bicarbonate, potassium citrate, sodium and potassium tartrate and sodium bicarbonate, taken in plenty of water from one half to one hour

before meals, are very serviceable in these cases when indicated by the urine. Those suffering from renal insufficiency should be treated by hot-air baths, which modify the nutritive, nervous, and circulatory conditions in some manner as yet not fully understood. They may act by favoring elimination in some degree, although Von Noorden and others maintain that profuse diaphoresis does not result in the elimination of urea by the skin, which substance, although itself apparently not a poison, may be taken as an index of the amount of other noxious substances eliminated by the kidneys. Constipation should be effectually overcome: the saline waters, such as Carlsbad, Hathorn, Friedreichshall, Rubinat-Condal, or Hunyadi Janos, may be used; aloin, podophyllin, cascara, and other vegetable cathartics are serviceable. Once or twice a week the colon should be flushed with two quarts of hot water or boric acid solution introduced through a flexible rubber colon tube, passed from eighteen to twenty-four inches into the bowel with the patient lying upon the back or right side, the hips being somewhat higher than the shoulders. Gouty manifestations call for the use of gold and sodium chloride, potassium iodide, and colchicum, together with a diet most in accordance with the condition of the gastric chemistry that may be present, hot-air or Turkish baths, and elimination by way of the bowels and kidneys, etc. If the gastric condition bears a relation to an old syphilitic infection—as, for instance, in some cases of obstinate gastralgia or nausea that have fallen under our observation and which we have elsewhere described—potassium iodide should be used in ascending doses. Hydrotherapy is most valuable, the different forms of the cold spinal douche being employed in conjunction with the shower bath or the rain bath, half bath or plunge. In the use of hydrotherapy for any purpose attention to exact technique is of supreme importance, as Baruch has particularly emphasized. Sea bathing is decidedly beneficial in some cases, while with others it disagrees. Electricity in the form of the static spray, general faradization, or the continuous current, used along the spine and over the epigastrium, may be serviceable. Medical gymnastics are measures of the highest importance in the treatment of the neuroses. If nerve irritation is present, tonics and sedatives may be judiciously combined. If the vitality is low and the case shows general depression, strychnine or nux vomica in increasing doses should be employed. The tincture of nux vomica, commencing with five or ten drops, increasing the dose one drop a day up to forty or even sixty drops three times daily before meals, as recommended by Musser, may be administered; or strychnine $\frac{1}{30}$ of a grain, increasing to $\frac{1}{20}$, may be given four times a day. Quinine in moderate doses is useful, especially in malarial regions and in those who have had malaria. If anæmia is present, iron or red bone marrow may be administered; anæmia is a commonly associated condition and may be in a measure a causative factor. In a large number of cases it will be found that blood pressure is persistently too low, for the relief of which the long-continued use of small doses of digitalis or strophanthus is especially recommended. Plenty of nutritious food should be insisted upon, and we wish to emphasize the prime importance of physiological remedies in preference to over-medication. The rest-cure when it is indicated is often attended with signal success.

PEPTIC ULCER.

This morbid process, first placed on firm pathological ground by Cruveilhier, must be distinguished from the various forms of ulcers common to other tissues as well as to the gastric mucosa. It is not an ulcer according to the common acceptance of the term, but is a local necrosis resulting from the action of the gastric juice upon a focus whose resisting powers are for some reason diminished.

Localized suppuration of the gastric mucosa may result from infection carried by the blood or by the stomach contents; erosions may result from the introduction of overheated or toxic substances and from other causes. Musser has shown that tuberculosis, and Guzot that syphilis, produces ulceration of the gastric mucous membrane. Heller thinks that syphilis plays an important rôle in congenital ulcer. Albertoni reported a case in which ulcer was complicated with adenoma of the stomach, and Turner described a superficial slough of the gastric mucosa in a man suffering from pyæmia. We have seen erosions resulting from extravasation of blood in the substance of the mucosa in cases of purpura and scurvy, and Wales reports that such lesions are rarely absent after death from the latter affection. Quioroza reported instances of ulcer resulting from dysentery, puerperal septicæmia, and typhoid fever. The ulceration of gastric carcinoma may be added to this list, and yet none of these conform either clinically or histologically to the type of peptic ulcer, or, as it is often called, simple, solitary, round, perforating, or the "ulcer of Cruveilhier."

Etiology.—There has been a general acceptance of the views of Virchow that ulceration follows hemorrhagic erosions resulting from disturbances of the circulation, and that the interruptions of the circulation for the most part are due to morbid conditions of the gastric vessels, and particularly to hemorrhagic necrosis of the mucous membrane. Given such local disturbance and an active gastric secretion, the digestion and disappearance of the necrotic areas would naturally follow. There has accumulated considerable evidence that thrombosis plays a rôle in the process. Berthold found disease in the circulatory apparatus in 170 of 294 cases; Steiner reports such changes in 71 out of a total of 110 cases, finding endocarditis, endarteritis, and endaortitis. Thrombosis in various parts was demonstrated 48 times. Janeway described a case in which the ulcer was directly due to a fibrinous plug found in the gastro-epiploic artery. Provost and Cotard produced ulcer in various parts of the alimentary canal by introducing tobacco seeds in the aorta. By experimental means hemorrhagic necrosis, and later ulceration, have been produced by several investigators. Ritter succeeded by poking a dog's stomach with a cane, and Decker reports like results from feeding scalding gruel to dogs. After establishing gastric fistulæ, Quincke injured the mucous membrane of dogs by pinching, excising, and tying off small portions, and by applying thermal and caustic irritation; the animals showed no subsequent distress nor was the digestion impaired, and the ulcers disappeared after a few days, although the repair was delayed by producing artificial anæmia by bleeding. Von Soerhn and Silberman advance reasons for believing that lowered alkalinity of the blood is conducive to ulcer.

Typical round ulcers have been known to follow severe blows upon the abdomen or extensive superficial burns.

Localized pressure applied over the epigastrium, as is required by some occupations—as, for instance, in shoemaking—is mentioned as a cause. Zielinski considers narrowing of the lumen of the gastric vessels through traction produced by enteroptosis a cause of gastric ulcer. The teaching of Pavy that the normal alkalinity of the blood enabled it successfully to oppose the development of peptic ulcer, and that the appearance of the affection must therefore in part depend upon the lowered alkalinity, gained much credence until Samuelson rendered the blood neutral and showed that the stomach continued to resist its own secretion, thus disproving the theory. It has been generally held that the gastric juice had invariably a high acidity in gastric ulcer. This view had the support of Riegel. More careful chemical studies of the gastric contents have revealed the fact that, while hyperacidity is the rule, it is by no means the law. Ritter and Hirsch suggest that the hyperacidity is quite as likely the result as it is the cause of the ulcer. Free hydrochloric acid is more often absent than is commonly believed; Gerhardt found it absent in 7 out of 24 patients appearing at his clinic. There seems to be some relation between the lowered alkalinity of the blood and the excessive gastric acidity seen in the majority of cases. There can be no doubt that the presence of high acidity materially delays the healing of the ulcer, and there may be truth in the theory that in the presence of lowered alkalinity of the blood and a high degree of acidity in the gastric secretions a comparatively slight disturbance of the part might give rise to a chronic peptic ulcer. Admitting these predisposing factors, there must be some other influence that interferes with the nutrition at the site of the lesion. The theory that the nervous system is responsible for the local disturbance was long ago suggested. Schiff, Ebstein, and Ewald have each experimented by injuring certain parts of the central nervous system (optic thalamus, pedunculus cerebri, and spinal cord), and succeeded in producing quite uniform changes in the gastric mucous membrane. Thalma led to the formation of ulcer by exciting spasms of the muscular coat of the stomach through prolonged stimulation of the left vagus. Through some such effect may be produced those gastric and duodenal ulcers that appear after extensive superficial burns. In this connection the writer has called attention to the occurrence of local necrosis in other parts of the body apparently depending upon nervous influences; such are hæmatoma auris, herpes of the tonsil, herpetic gangrene, and Raynaud's disease. It is a singular fact that the ulcer is most frequently found near the pylorus, and generally toward the lesser curvature or upon the posterior wall of the stomach. Ewald suggests that this may be owing to the gravitation of the gastric juice to the lower end of the stomach when the patient is in the upright position. This might be considered the predisposing cause, but it seems necessary to include some other factor to account for the predilection shown by the disease for this region. Gastric ulcer occurs more often in women than in men —Ewald claims in the proportion of two to one—and this has been our experience. In a series of 90 cases reported by Eichhorst, when the diagnosis was made clinically the ratio in which ulcer appeared in males

and females respectively was as 71 to 73. More than 75 per cent. of all cases are found located near or in the pylorus. It rarely appears upon the anterior wall, but when thus located, owing to greater exposure to movements of the viscus against the abdominal wall and to blows upon the abdomen, it is more likely to proceed to perforation. It may develop in any portion of the stomach wall, and similar processes are observed in the upper part of the duodenum and lower part of the œsophagus.

Pathological Anatomy.—In size the ulcer is from a half to two inches in diameter. It is not often more than one inch across, although one instance is recorded of an ulcer which was more than six inches in length and between two and three inches in breadth. The area of the stomach wall involved by the ulcer is usually round or oval in form, except in chronic cases, when, owing to cicatrization, it is often somewhat irregular. Its margins are smooth, and there is an absence of inflammation in the adjacent portions of the mucosa, although slight extravasations of blood are occasionally seen in these parts. As it invades the deeper structures of the stomach the ulcer assumes the form of a truncated cone, which is more strikingly seen when the necrotic process reaches through the muscularis. The base of the ulcer may be the submucosa, the muscular coat, the serous coat, or it may end in a mass of connective tissue springing from the peritoneum or in some neighboring solid organ. As pointed out by Virchow, the direction taken by the ulcer bears a striking correspondence to that of the branches of the arteries running along the curvatures of the stomach—a fact which affords evidence that the cause of the ulcer is involved in local defects of the blood supply. In very acute cases perforation of the serous covering is apt to occur, particularly when the ulcer is located in the anterior gastric wall. Under these circumstances the discharge of gastric contents into the peritoneal cavity is probable. Perforations through the posterior wall into the lesser peritoneal cavity have been reported by Chiari. Through the extension of the ulcer and the limiting inflammation of the surrounding structures a sinus may be formed which allows a communication of the stomach with the large or small intestines, the pleural cavities, the lungs, the pericardium, and even the left ventricle of the heart. Gastric ulcer is often recurrent, and frequently continues as a chronic affection. When it recurs it is prone to appear near the original site. Repair takes place through an increase of connective tissue, which by subsequent contraction gives rise to a somewhat depressed, comparatively white scar, and the surrounding mucous membrane may present a puckered appearance. If the ulcer has been superficial or small, it is possible for repair to be so perfect as to escape the notice upon ordinary inspection. In frequently recurring ulcers and in chronic forms of the disease the excessive connective-tissue growth gives rise to marked induration around the border of the ulcer, which leads to decided deformity of the viscus. In this manner stenosis may occur at the pylorus, or when other points of the stomach are affected the cicatrix may be sufficient to cause the so-called "hour-glass contraction," thus dividing the organ into two pouches connected by an isthmus. We have seen three instances of this deformity, in two of which an unlike gastric chemistry existed in the two

pouches of the stomach. The deformity of the stomach may be increased through inflammatory adhesions to other organs. It has been noted that in those cases in which severe hemorrhage has occurred a chronicity in course is usual. Numerous instances are recorded of an open arterial twig in the floor of a chronic ulcer.

Symptoms.—As a rule, in the clinical history of gastric ulcer the diagnostic symptoms of the disease are preceded by a period in which complaint is made only of digestive disturbance and anæmia. The appetite is unimpaired, but eating is followed by gastric uneasiness or distress with eructation of gas and sometimes acid regurgitation. These symptoms gradually or sometimes suddenly increase in severity, until the uneasiness becomes nausea and the distress becomes pain, which latter symptom is almost invariably limited to a small area situated over the site of the ulcer. The tenderness and pain do not shift from place to place, but are confined for weeks together to a single spot not larger than a half-dollar. The pain sometimes radiates to the back, and when the ulcer is located on the posterior wall of the stomach the pain may be felt in the back only, a little to the left of the tenth dorsal vertebra. In the majority of cases the tenderness and pain will be felt just to the right of the median line and an inch or two below the ensiform cartilage. The pain is usually described as burning or gnawing in character; it appears immediately after eating, is sometimes continuous, but is generally alleviated when the stomach contents pass onward or when vomiting occurs. The pain is sometimes very severe, making sleep or rest impossible, and, although desiring food, the patient often denies himself, knowing that eating will increase his sufferings. At other times the pain is insignificant, and the ulcer may be unsuspected until hemorrhage makes its presence known. Vomiting in gastric ulcer sometimes occurs with little preceding nausea. The matter rejected is usually, but not always, intensely acid. At times vomiting occurs immediately after meals and with striking regularity, or it may occur at intervals of several days.

Gastrorrhagia in connection with these manifestations is regarded as the cardinal symptom of gastric ulcer, but, as before stated, may occur without previous evidence of the disease. This, however, is not common. As a rule, the hemorrhage is accompanied by nausea and vomiting, and the amount of blood lost is sometimes very large. It is hard to estimate the quantity, for the gastrorrhagia sometimes continues at intervals for several days, and, besides what is vomited, a considerable amount of blood passes the pylorus and is discharged through the bowels, giving rise to so-called tarry stools. It is not uncommon for the patient to vomit a pint or more of arterial blood, although if it has been retained some time in the stomach it may be clotted and dark in appearance. The patient may become exsanguinated, and syncope is a common event, for which fright is perhaps somewhat responsible. In a proportion of cases death from hemorrhage follows—an event that must be less frequent than believed by Brinton, as we have never seen a fatal case of gastrorrhagia from this disease. As will be seen, the classical symptoms of gastric ulcer are localized tenderness and pain made immediately worse by eating, nausea and vomiting, sour stomach contents and hæmatemesis, the hemorrhage being arterial in character and usually

large in quantity. The anæmia that is sometimes seen is a premonitory symptom of gastric ulcer, but is believed by many to be the result of the disease rather than a predisposing factor. It certainly is absent in the beginning in a fair proportion of cases, but invariably appears later in the disease, partly because of limitations in food, the vomiting, the disturbance in digestion, and the loss of blood. Many cases are reported of young females who have suffered for months from chlorosis and amenorrhœa who have finally developed gastric ulcer. Habitual constipation is the rule in these patients—a condition that is commonly present when ulcer is active. Attention has been called to the presence of neurotic tendencies in those who suffer from this disease, and some assert that this affection is most common in those having a nervous temperament. Probably this is true in a considerable number of cases, but it must be acknowledged that there is no special type in which the disease appears. The early digestive disturbances to which reference has been made are usually dependent upon hyperchlorhydria; that is to say, there is a rapid solution of the proteids, and the starch digestion is cut short too promptly, so that amylaceous food causes irritation of the stomach. In the beginning of many cases the clinical picture of ulcer of the stomach is almost identical with that of hyperchlorhydria, and attention is called to the symptomatology described in the section on that affection (p. 112).

Diagnosis.—The cardinal symptoms of gastric ulcer are digestive disturbances, followed by pain and tenderness localized to a small area, usually immediately to the right of the median line and slightly below the ensiform cartilage, and made worse by eating, first appearing immediately after meals; nausea and vomiting of very acid stomach contents; the appearance of hæmatemesis and melæna. The vomited blood is abundant and arterial in character.

In early life hæmatemesis is more indicative of ulcer than in middle or later life, when malignant disease and cirrhosis of the liver are more common. It is important to exclude hæmatemesis not arising from gastrorrhagia. We have seen errors in diagnosis made when vomiting of blood occurred in chlorotic young women suffering from indigestion, and the blood finding its way into the stomach after hæmoptysis, epistaxis, or bleeding from other parts. When hemorrhage is absent the diagnosis must be based chiefly on the localized pain and tenderness, together with other symptoms common to ulcer and these affections. It therefore becomes important to differentiate between gastric ulcer and hyperchlorhydria, acute catarrhal gastritis, gastralgia, cholelithiasis, carcinoma ventriculi, and intercostal neuralgia accompanying digestive disorders, and finally duodenal ulcer.

In hyperchlorhydria the distress, nausea, or pain is usually temporarily relieved by taking food, and returns an hour or more after eating when the total acidity has risen; whereas in ulcer these symptoms are immediately made worse by eating. In hyperchlorhydria the pain and tenderness are not strictly localized as in ulcer. In acute catarrhal gastritis there is an accompanying constitutional disturbance, usually fever, anorexia, and toxæmia; the vomited matter usually has a high acidity, but it depends upon the presence of the organic acids; the tenderness and pain are more diffused than in ulcer. In gastralgia there is some-

times vomiting, but there is no rule as to the nature of the stomach contents; the pain is often aggravated by eating, and the diagnosis between this affection and ulcer is sometimes made with difficulty. There is irregularity in the duration of pain and absence of localized tenderness, and in other respects the history of the attack is that of neuralgia rather than of gastric ulcer. This is also true of intercostal neuralgias that accompany digestive disorders, and the tenderness along the course of the nerves is quite indicative of the affection. In duodenal ulcer the pain is most likely to occur an hour or more after taking food; it is usually very intense in character, and is accompanied by localized tenderness somewhat farther to the right than that seen in gastric ulcer. Melæna sometimes occurs without the vomiting of blood, although it must be remembered that hæmatemesis is often present. Differentiation between carcinoma and ulcus ventriculi may be best understood by the following comparison of symptoms:

	Ulcer.	Cancer.	Gastralgia with Indigestion.	Acute Gastritis.
Age.	Most common before middle life.	Rare before middle life.	At any age.	At any age.
Pain.	Immediately after meals, severe, localized.	Irregular, less localized, often absent.	Intense, not localized, little influenced by meals.	Diffuse, not severe, increased by food.
Tenderness.	Marked, localized.	Notmarked, sometimes absent, less localized.	Superficial, diffuse, sometimes absent.	Diffuse, deep.
Vomiting.	After meals; very acid.	Irregular, perhaps persistent; mucus and perhaps stagnating food.	Often absent.	Frequent; intolerance of food.
Hæmatemesis.	Abundant, arterial.	Usually scant, blended with mucus; coffee-ground appearance.	Absent.	Blood-stained mucus, and retching is present.
Digestion.	Rapid of albuminoids; starches delayed.	Poor, sometimes absent.	Slow.	Absent.
Chemistry.	HCl in excess, total acidity high.	HCl absent; lactic, acetic, and butyric acids present.	Variable.	HCl temporarily absent; organic acids often present.
General Condition.	Chlorosis.	Cachexia; tumor present.		

Prognosis.—The prognosis of gastric ulcer has become less serious since the importance of an early diagnosis has been realized. While the proportion of neglected cases which terminate fatally by perforation or hemorrhage is unknown, it is found that those that receive early treatment almost invariably go on to cicatrization even when severe hemorrhage has occurred, so that if this does not prove immediately fatal, recovery is to be expected. In 26 out of 93 reported fatal cases death resulted from perforation, although hemorrhage was present in some of these. Formerly perforation was supposed to be necessarily fatal, but by surgical interference a reasonable proportion of these cases may be saved, as recent literature shows. Death sometimes results from hemorrhage when the ulcer is latent and has escaped diagnosis. A proportion of cases terminate in death as the result of exhaustion

caused by vomiting and pain that might be averted by satisfactory treatment. If those cases that through cicatrization lead to pyloric stenosis and other deformities of the stomach are taken into estimation, the gravity of the disease increases. It has been said that such deformities are made less frequent by early treatment. The prognosis of the disease, therefore, depends largely upon timely and appropriate therapeutic measures, and, although a small number may end in death, a favorable result may be anticipated with an early diagnosis and proper management.

Treatment.—In the treatment of gastric ulcer the aim is to relieve pain, tenderness, gastric distress, and vomiting; to control hemorrhage, to improve general nutrition; and, finally, to promote the rapid healing of the ulcer. Success in the accomplishment of these aims largely depends upon early diagnosis. As has been stated, upon the chronicity of the ulcer will depend the extent of the resulting cicatrization and the subsequent deformity of the stomach. Neglected cases are much more likely to be attended with gastrorrhagia. Rest is almost indispensable in the treatment of gastric ulcer, and the safest plan is to require the patient to maintain the horizontal position in bed, sufficiently isolated to provide mental rest. This is too often omitted except when hemorrhage has occurred. In subacute or chronic cases the patient is usually allowed moderate exercise and to engage in light occupation, but it must be conceded that such liberty directly retards the healing process and leads to the continuance of the affection. The importance of rest can hardly be too much insisted upon, and the only excuse for its omission that can be advanced is uncertainty in diagnosis. Where there is a reasonable doubt as to the nature of the disease, it is wiser to decide in favor of ulcer, as absolute rest is not incompatible with the best treatment of the other affections for which ulcer may be mistaken. As a rule, the pain, tenderness, gastric distress, and nausea are present in direct ratio to the degree of the acidity of the stomach contents. When there is a high acidity there is much distress, whereas in low acidity the ulcer is often latent and sometimes unsuspected until hæmatemesis appears. The most rational method of relief of these symptoms, therefore, will be the administration of those remedies that will neutralize the acid of the stomach contents and diminish the secretion of gastric juice.

The rules that have been prescribed for the treatment of hyperchlorhydria (page 113) will also apply in the treatment of gastric ulcer. The administration of a combination of cerium oxalate, bismuth subcarbonate, and the light magnesium carbonate in large and often repeated doses will be found to afford marked relief to all the symptoms, and, if proper rest and suitable diet are prescribed, to their rapid disappearance. We have had prepared a mixture of these three salts in the proportion of one, two, and four parts respectively, in the form of a hydrate, of which a tablespoonful may be given every hour or two according to indications. It will be found that this preparation acts as a mild purgative, which is rather desirable than otherwise, as constipation is commonly present in peptic ulcer. When the evacuations become too frequent, they may be controlled by the addition of small doses of kino or other astringent. Sometimes the addition of creta

præparata and the strontium lactate or bromide is serviceable. The time-honored lime water, used with or without milk, is a useful antacid, and in some cases acts as a gastric sedative, but is of service only when given abundantly. The more active astringents—as, for instance, the iron preparations and the silver nitrate—have no real place in the treatment of this disease. The latter drug has had many advocates, but it has gradually fallen into disuse as the disease has become better understood. There can be no doubt that atropine lessens the gastric secretion, and some cases that are only partly relieved by the measures before described are made comfortable by the use of $\frac{1}{100}$ of a grain of this alkaloid administered once in four to eight hours. Ichthyol often relieves the painful symptoms, and taka-diastase may also be of use. Opium promptly relieves the pain and often most of the other symptoms of peptic ulcer, but its use is attended with so many objections that it should not be employed except in case of hemorrhage. Some of the most deplorable instances of the opium habit have arisen from patients having recourse to the drug for the relief of the symptoms of chronic ulcer. When we consider the activity of the symptoms of this affection, it is somewhat surprising to note how frequently no complaint is made until hæmatemesis occurs. The physician is therefore sometimes brought in the first place to treat hemorrhage rather than gastric ulcer. It so happens that the principles of therapeutics in the two conditions are not incompatible. In gastrorrhagia the patient should be kept perfectly at rest in bed, in an isolated dark room, with an ice bag over the epigastrium, and should be given morphine hypodermically in sufficient doses to procure complete mental and bodily composure. Fifteen minims (1 c.c.) of the aqueous extract of ergot or its equivalent of ergotine should be given hypodermically, and this should be repeated every four hours until six or eight doses have been given, or more frequently if the hemorrhage recurs. The patient's mouth may be moistened with tepid water, but the eating of shaved ice that has been so largely advised should be omitted, for the reason that it stimulates the secretion of gastric juice and is more likely to do harm than good. The incessant thirst that follows severe hemorrhage is best relieved by the injection of water *per rectum*. The patient should receive no food *per os* for at least three days after the last evidence of hemorrhage has disappeared. Rectal alimentation should be practised, and the food selected should be milk reinforced by uncooked eggs and perhaps thoroughly boiled pap. When using this method of alimentation the colon should be cleared once daily by a large lavement of saturated solution of boric acid. It is generally advised that when feeding by the mouth is resumed the patient should take only minute quantities of milk. There can be no doubt that milk is the proper, and in most cases the only, food allowable, in which respect we have not improved upon the dictum of Cruveilhier, who first described the disease and recommended a milk diet for its treatment; but experience has taught us that when the patient begins to take nourishment in the natural way, it is proper to give peptonized milk or lime water in milk frequently and in considerable quantity. At first a tablespoonful may be given every hour, and after a few portions that amount should be doubled; the following day four ounces of milk may be given every two hours, provided the bowels

have been thoroughly opened by castor oil assisted by stimulating enemata. When castor oil is likely to induce emesis a full dose of calomel, followed soon by magnesium sulphate, may be preferred. As soon as it is thought safe to discontinue the use of morphine, which is usually after the lapse of forty-eight or fifty-six hours, the administration of the gastric sedatives before mentioned should be resumed. These remedies should be used in conjunction with the milk diet, administered between the portions of milk. The stomach should never be over-distended with milk or water, but with this precaution the more the gastric contents are diluted the better. In any case of gastric ulcer, and particularly after gastrorrhagia, the milk diet should be continued until the pain and all tenderness upon pressure have subsided. Then a more generous diet may be allowed, but it should be gradually resumed, beginning with the addition of egg albumen, pap, and other forms of thoroughly cooked, dry, starchy food, such as zwieback and the crusts of twice-baked bread or rolls. The anæmia and prostration sometimes offer formidable problems in treatment when the more urgent and tragic symptoms of gastric ulcer have subsided. Iron should be employed in the form of the albuminate, and as soon as the ulcer is presumably healed albuminoid food should be given frequently and in as large quantities as is compatible with good digestion. The patient should be urged into the sunlight and open air, and systematic massage should be employed, omitting, of course, all treatment of the abdomen. Along these principles of treatment most gastric ulcers heal quickly and the patients are restored to perfect health, unless serious deformity of the stomach has occurred. When convalescence is established the patient should be instructed to report regularly for observation as to returning chlorosis or other symptoms indicative of recurring ulcer. By this precaution a second attack may be averted, and accounts of gastric ulcer lasting fifteen or twenty years will be less frequently recorded.

CARCINOMA OF THE STOMACH; OTHER TUMORS.

Definition.—A malignant new growth of the stomach, usually primary, sometimes secondary, accompanied by gastric symptoms and progressive loss of flesh and strength, and with grave secondary anæmia. The disease seldom lasts longer than from ten months to one and a half years after its discovery, and ends fatally.

Etiology.—Gastric carcinoma occurs most frequently between the fiftieth and sixtieth years of age. Almost as many cases occur in the decades between forty and fifty on the one hand and sixty and seventy on the other. Approximately, three fourths of all cases occur between forty and seventy years of age. About 13 per cent. are observed between the thirtieth and fortieth years. It may happen in the young or in the very old. It is extremely rare in childhood. Sex exerts no apparent influence upon the frequency of the disease, although statistics give a slight preponderance to males. A predisposition to cancer is probably inherited in some families, as not infrequently one or more members for several generations die of the disease. It is not, however,

as important an etiologic factor as was formerly supposed or as is considered to-day by some.

Gastric carcinoma has been said to be more common in Europe than in the United States. It has been reported as relatively infrequent in tropical countries, but we have no proof of the accuracy of this statement. Welch found that relatively fewer negroes than whites died of carcinoma in New York City, so that race may have some influence upon its frequency. The disease may commence in the cicatrix of a gastric ulcer, and chronic catarrhal gastritis and blows upon the epigastrium have been thought to predispose to its development. It occurs most commonly at or near the orifices of the stomach, and may be somewhat dependent upon local irritation. The parasitic origin of the disease has received much attention of late, some investigators having found sporozoan bodies in carcinomatous tissue which are supposed to bear a causative relation to the neoplasm. It has been recently suggested that the yeast plant may cause the disease. Woods Hutchinson emphasizes the theory that the pylorus among ancestral remains is especially prone to carcinoma.

Pathological Anatomy.—The varieties of carcinoma occurring primarily in the stomach are scirrhous, encephaloid, colloid, and cylindrical celled epithelioma. The situation of the neoplasm is commonly near or involving the pylorus, while it occurs next in frequency at the cardia and least frequently in the fundus. The lesser is the seat of the growth more often than the greater curvature. The scirrhous is the most frequent, although the medullary and cylindrical celled epithelioma are also quite common forms of gastric carcinoma. Scirrhous carcinoma is hard, owing to its abundant stroma and its few small alveoli. It may appear as a diffused or circumscribed thickening of the walls of the stomach. It may be tolerably smooth or present hard nodules projecting from the body of the growth. It occurs with the greatest frequency at the pylorus, where it commonly causes stenosis. The medullary is soft, appears in irregular masses, and usually ulcerates; large growths sometimes resembling cauliflower are seen in this form. It is grayish in color, although it is well filled with blood; it involves all the coats of the stomach, and so readily ulcerates that it is more likely to cause hemorrhage or perforation; and metastases are more common in this than in other forms. Microscopically, the stroma is scanty, contains bloodvessels and numerous alveoli with cylindrical and polyhedral cells. Cylindrical celled epithelioma is firmer than, but may resemble, the medullary carcinoma. This form is probably derived from the gastric tubules, as, microscopically, spaces are seen resembling sections of tubular glands lined with columnar epithelium. Cysts are not uncommonly seen in this form. The stroma is abundant in some and scanty in other instances.

The colloid variety usually involves the whole thickness of a large part of the stomach; it is sometimes called alveolar carcinoma, as many well-defined alveoli are seen filled with gelatinous, translucent colloid material, which substance is seen also in the stroma, but only in small quantities as a rule. Secondary colloid deposits are often seen in other organs, or it may spread from the stomach to adjacent organs or structures.

Cylindrical epithelioma commonly undergoes colloid transformation. A form of epithelioma designated as the squamous or flat celled originates in the œsophagus and involves the cardia by extension.

Secondary gastric carcinoma is rare; it may occur, however, secondarily to carcinoma of the œsophagus, mouth, upper air passages, or other parts. The stomach is deformed in various ways by carcinoma, dilatation from pyloric stenosis being common. The capacity of the stomach, on the other hand, may be much diminished, as in diffuse scirrhous carcinoma, which macroscopically sometimes resembles a gastric sclerosis. Gastroptosis is common from the weight of the tumor, or more often from the weight of the contents of the dilated stomach. The pylorus may be displaced downward as far as, or even below, the umbilicus, the axis of the stomach being changed by such displacement. Metastatic growths are frequently found in the liver, peritoneum, omentum, and pancreas, occurring less commonly in the lungs, pleura, brain, spleen, and other regions.

Symptoms.—Early in the disease there may be few or no symptoms, but in a proportion of cases distress, pain, and gastric flatulency occur, especially after meals, for a considerable period before the true nature of the malady becomes manifest. The symptoms may be divided into those relating directly to the stomach and those secondary to the gastric disease. The character of the symptoms depends somewhat upon the location of the neoplasm, and, as the pylorus is the most common seat of the disease, they are usually indicative of obstruction at that point. Vomiting may occur at intervals early in the disease, and may not be copious. This may be attributed by the patient to some particular article of food disturbing to the stomach, as the symptoms subside and may not again be noticed for a considerable period. Then comes a time when meals are followed by vague distress, which persists or returns with greater frequency and is accompanied by noticeable loss of flesh and strength. Vomiting now becomes more frequent owing to increasing gastrectasia and food stagnation. The greater the food stagnation the more copious will be the vomiting, and when dilatation is extensive several pints may be ejected at one time. Vomiting may occur in the night or in the morning before breakfast, and food will be found that was eaten some days previously. In some cases no pain is complained of at any stage of the disease; on the other hand, pain may be early and persistent, having its location in the epigastrium, though not as sharply defined as in ulcer. While usually near the pylorus, it may radiate in various directions, sometimes being aggravated by food and at other times bearing no relation to the meals. Sometimes belching occurs, and early may be mild and not distinctive of organic disease, while later it may become more frequent, and the gases expelled may be foul smelling, owing to fermentation and putrefaction of the stomach contents. Rare instances have been reported of inflammable gases having been belched from the stomach. If the growth is located at the cardia, dysphagia and regurgitation of food as soon as it is swallowed are important symptoms. If only partial obstruction exists, swallowing may be slow, painful, and difficult. Dilatation of the œsophagus usually occurs as a consequence of obstruction at the cardia, frequently cylindrical in form, sometimes becoming sufficiently

extensive to allow 500 c.c. or more of food to collect and remain for a considerable period. This may be washed out by the stomach tube, and upon examination will be found not to have undergone digestion, with the possible exception of that which occurs from continued salivary action or that which may have occurred from the admixture of predigested foods or digestants, such as pepsin and hydrochloric acid. In case the fundus is the seat of the growth, the capacity of the stomach is apt to be much diminished, and since fulness and distress may supervene upon the ingestion of a small quantity of food, vomiting may occur immediately after eating. We have observed a case of this nature in an old man who suffered almost continuous severe pain in the epigastrium and vomited frequently, whose stomach was found at autopsy to have a capacity about sufficient to admit a man's index finger. In this case food was tolerated only in small quantities at a time. Frequently in these cases the pylorus is patulous and the food passes freely into the intestine. Constipation is a common symptom in this disease, and is most marked in those cases having new growths so situated as to cause obstruction. It is almost always, therefore, a constant accompaniment of obstructive pyloric carcinoma. Diarrhœa may, however, alternate with constipation, and may result from intestinal putrefaction consequent upon gastric fermentation. Hemorrhage is not usually profuse, although in cases of extensive ulceration—as, for instance, in medullary cancer—it may be abundant. For the most part, however, bleeding is slow and oozing in nature, the blood becoming clotted and changed in the stomach, being vomited or washed out in a condition resembling "coffee-grounds." Occasionally quite large clots are formed in the stomach, which usually undergo disintegration and pass through the stomach tube with little or no difficulty. Hemorrhage is more frequent in medullary carcinoma and cylindrical celled epithelioma than in the scirrhous variety. The blood from the stomach may pass by the bowels in large or small quantities, usually the latter. Loss of flesh and strength commences early and usually progresses steadily, and late in the disease emaciation is very marked and weakness is profound. In some cases the symptoms abate for a short time and general improvement occurs, in so far that a false hope is encouraged and the clinician may doubt his diagnosis; but the disease soon reasserts itself. Anæmia is seen in various degrees, there being early secondary chlorosis of a mild type, while in the late stages of the disease a severe form of chlorosis or a pernicious type of anæmia may be found. The red blood cells are not infrequently reduced as low as 1,000,000 per cubic millimetre, and hæmoglobin as low as 35 or 40 per cent. Usually megalocytes, macrocytes, microcytes, and normoblasts are present. In the chlorotic types the red cells are very pale, while in the pernicious type they are surcharged with hæmoglobin. Gigantoblasts are also seen in the pernicious type. Moderate leucocytosis is found, as a rule, in gastric carcinoma, and may depend upon ulceration of the neoplasm.

The so-called cancerous cachexia is not always seen, although the appearance of the patient is cachectic in a large proportion of cases. The skin often assumes a yellowish or lemon color, while the lips and mucous membranes may be very pale. Sometimes irregularly shaped areas are deeply pigmented, especially upon the hands, wrists, face,

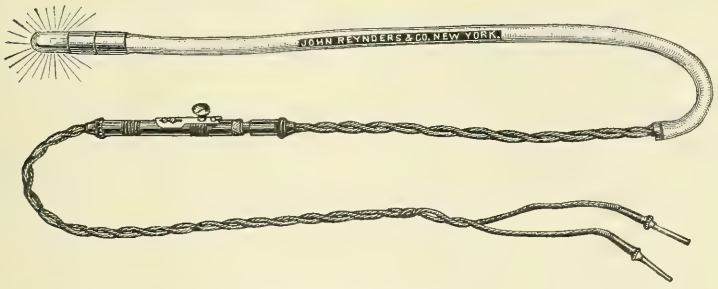
forehead, and neck, or in some cases the skin may appear universally pigmented, resembling Addison's disease. The urine is sometimes superacid and sometimes phosphatic; the specific gravity is usually somewhat low, the urea being diminished, but not more so than occurs in other diseases accompanied by equal malnutrition and emaciation. Albumin may or may not be present; sugar, as a rule, is absent, but may be present, especially if the pancreas becomes involved secondarily; some observers have found peptonuria and acetonuria; indicanuria is quite common. In making routine examinations for indican we have found it in this disease in about 60 per cent. of the cases, but we do not find that it bears any definite relation to the absence or presence of free hydrochloric acid in the gastric contents, as we have found it in cases having free hydrochloric acid in the stomach as well as in those without it. In the generally depraved condition of the blood and tissues it is not a rare thing to find a few hyaline casts, especially when the urine is centrifugalized, and they do not necessarily indicate a nephritis. Œdema may occur along the tibia, around the ankles, or in other parts; it probably results from hydræmia and poor circulation. We have an interesting case under observation at the present time in which thrombosis of the femoral vein occurred and gave rise to œdema of the left leg, which persisted for a considerable period.

Physical Examination.—The neoplasm is not always palpable, and if the cardia is alone involved, it cannot be felt through the abdominal walls. The lesser curvature and posterior walls may also be involved and at no time be palpable. New growths involving the pylorus are usually palpable. If the anterior or greater curvature happens to be the seat of the neoplasm, it is easily palpable, unless covered by a distended colon or obscured by thick or tense abdominal parietes. The stomach is frequently displaced downward by the new growth or by the weight of its contents, so that almost the entire viscus may be reached by palpation. It should be remembered that when gastroptosis is thus extensive the pylorus especially is liable to be dragged far out of place. The displacement is most marked when gastrectasia is present. The tumor is usually, however, felt in the epigastrium, perhaps a little to the right of the median line, is somewhat movable, irregular in contour, and firm in consistency. When the stomach is full, it may be pushed one or two inches to the right of the median line, while if the stomach is empty, it is felt higher up and to the left of the median line. The axis of the stomach is changed by the altered position of the pyloric extremity, as will be manifest at a glance. The dilatation resulting from carcinoma of the pylorus may be slight or extensive. The lower border of the stomach may reach the pubes, as occurred in some of our cases, associated with some degree of gastroptosis. After the stomach is emptied by lavage a tumor which before was not palpable may then be easily felt. The presence of gastrectasia may help in diagnosis, as it is such a common result of pyloric carcinoma. In some cases, however, the disease may be considerably advanced, so far perhaps that the tumor is palpable, yet, notwithstanding food stagnation, no appreciable dilatation exists—a condition of things which may be explained by the occurrence of hypertrophy of the muscularis coupled perhaps with frequent copious vomiting, which reduces intragastric pressure and distention; or

the pylorus may be patulous, notwithstanding that it is the seat of carcinoma. Indeed, the pyloric orifice has been found at autopsy to be larger than normal in cases that clinically presented copious vomiting of foul contents and other evidences of food stagnation; it is difficult to explain the symptoms in these cases, although the contents have been supposed to regurgitate from the duodenum through the patulous pyloric orifice into the stomach, and thence to be vomited or washed out.

The stomach may be inflated with gas, and then the tumor may either become more prominent if situated in the anterior wall, disappear if located in the posterior wall, or be displaced to the right or upward or downward. The degree of gastrectasia will be manifested by the tympanitic percussion note over the gastric area, and the abdominal wall is also usually made to bulge out from the gaseous distention. Einhorn's gastrodiaphane may assist in determining the size and location of the neoplasm, as the transillumination shows with less intensity or not at all through the carcinomatous anterior wall of the stomach in contrast to the brighter light transmitted through the rest of the organ. By the

FIG. 3.



Einhorn's gastrodiaphane.

same method dilatation and gastroptosis are ascertained with considerable positiveness. The presence of thick abdominal walls renders the transillumination faint and inconclusive. Lymphatic glandular enlargement secondary to gastric cancer is most frequently found in the mesenteric, retroperitoneal, supraclavicular, and inguinal glands. Many writers mention the enlarged left supraclavicular gland as occurring with thoracic or abdominal malignant disease. Troisier particularly calls attention to this sign, but also admits its presence in other diseases. The gland specially referred to is to be felt behind and a little above the left clavicle, between the insertions of the sterno-cleido-mastoid muscle. We found it enlarged in a case of carcinoma involving the peritoneum and mesentery, but have frequently failed to discover it in cases of gastric carcinoma. Secondary carcinomatous deposits may be discovered in the liver, peritoneum, omentum, mesentery, or spleen. An important matter to be considered is the fact that a fecal mass may simulate a new growth, and therefore the colon should be emptied by a large enema and the abdomen examined thereafter. In the examination of the abdomen certain precautions ought to be observed: the patient should lie on his back, with the abdominal muscles relaxed as much as possible, and he should also be examined sitting, standing, lying on the

side, and in the knee-chest position, in order that the size, consistency, contour, movability, and relations of the tumor may be the more definitely determined.

After careful examination has been made by external manipulation, the stomach tube should be passed, as it not infrequently affords valuable information as to the location of the disease. In case the cardia is the seat of the growth, the tube will probably meet with obstruction at that point, which measures about fourteen inches from the teeth in adults. The obstruction may be complete or incomplete, or the tube may enter an œsophageal sacculation from which food may be withdrawn, in which case it is desirable to determine whether or not it comes from the stomach. Food withdrawn from the œsophagus presents for the most part an unchanged appearance, except that it is water-soaked and mixed with considerable mucus; it is not digested; hydrochloric acid is absent; there may be faint acidity from acid foods; no biuret reaction is obtained unless predigested albuminoid foods have been taken; starch may be digested by salivary action. If no dilatation of the œsophagus is manifest, organic may be differentiated from spastic stricture by anæsthetizing the patient, when, in the case of spasm, the tube or sound will usually pass easily into the stomach. If the fundus of the stomach is the seat of diffuse carcinoma, the capacity of the organ is commonly much diminished and a very small quantity of contents is withdrawn, showing perhaps no evidence of stagnation; hydrochloric acid is usually absent, while lactic acid may or may not be present. When the disease is situated at the pylorus, and consequent dilatation of the stomach is present, the tube may be inserted from twenty-six to twenty-eight inches beyond the teeth and bring up large quantities of yeasty, foul-smelling, dark, semi-fluid contents, with considerable ropy, tenacious mucus. Foods may be present that were eaten days or even weeks before, and disorganized or clotted blood may be found. The gastric filtrate in such cases usually has a high total acidity, being frequently 85 to 120 from accumulated organic acids with combined and, in a few cases, free hydrochloric acid. Usually, however, free hydrochloric acid is absent, but we have seen a number of cases in which it was present in the advanced stages of the disease: in some of these cases the carcinoma was grafted upon the cicatrix of an old ulcer; in all of them food stagnation existed with more or less gastrectasia. Hydrochloric acid was inconstant in some, while constant in others, but in every case it finally disappeared, not to return; its presence, therefore, is not positive evidence against the existence of gastric carcinoma. Considerable interest lies in the question of the presence of lactic acid and lactic-acid-forming micro-organisms in the stomach contents of carcinoma ventriculi. Lactic acid in the stomach must be considered under two distinct headings: First, its presence in the stomach as a preformed acid; second, its formation in the stomach after food free from lactic acid has been eaten.

In 1892, Martius and Luttke found that lactic acid was not a normal constituent of the gastric contents, and thereupon Boas investigated the subject, and in 1893 announced that all products of the bakery contained an appreciable amount of lactic acid. He devised for its detection a new method that is based upon the fact that manganese dioxide and sulphuric acid decompose lactic acid, forming acetic aldehyde and

formic acid (see page 100). Boas advised a test meal consisting of a gruel made with a tablespoonful of oatmeal flour to a litre of water, which may be flavored with a little salt. The stomach is thoroughly cleansed by lavage at night and the test meal given. The contents are withdrawn in the morning and examined. Boas found by this method that lactic acid was never present during normal digestion, nor in any abnormal condition of the stomach excepting carcinoma, in which disease it was almost invariably present. Cancer may exist, however, without the presence of lactic acid. A number of observers corroborated Boas' findings, and with him have concluded that the presence of lactic acid in the stomach after a test meal, in which it is not preformed, constitutes an early diagnostic sign of gastric carcinoma. We have found lactic acid by Boas' method in cases of carcinoma of the stomach, and in a few cases have been able by the assistance of this sign, with other important manifestations, to make early provisional diagnoses of cancer when no tumor was apparent. On the other hand, we have had cases in which no lactic acid could be found, notwithstanding the observance of careful technique, and yet gastric carcinoma was found on abdominal section in some of the cases and at autopsy in others. In all except one case, in which we found no lactic acid, free hydrochloric acid was present, but when it finally disappeared lactic acid was found. Upon ordinary diet lactic acid is not infrequently present if hydrochloric acid is much diminished or absent from any cause, especially in conjunction with motor insufficiency; therefore the conclusion seems warranted that in gastric carcinoma, accompanied by free hydrochloric acid, lactic acid is often absent even upon ordinary diet, and, while its presence may be of diagnostic value, it is by no means positive evidence of carcinoma ventriculi.

A variety of micro-organisms is found in the gastric contents, chief among them being the lactic-acid-forming bacilli; they are present also in chronic catarrhal gastritis, although not so abundantly nor so constantly as in carcinoma. These bacteria seem to find an especially favorable habitat in the degenerated epithelium of the mucous membrane in malignant disease of the stomach. Yeast cells are frequently found when there is food stagnation, and occasionally sarcinæ ventriculi are present, but not as commonly as in gastrectasia from benign pyloric stenosis. Besides these a long, delicate, threadlike bacillus ("faden" bacillus—Schlesinger and Kaufmann) is often present in carcinoma, but has not been found in other diseases of the stomach.

The rennet ferment and rennet zymogen are considerably diminished in carcinoma and also in chronic gastritis, more so in the latter than in the former disease, whereas in functional disturbances of the stomach they are apparently not affected. Under normal conditions the rennet ferment may be active in dilutions up to $\frac{1}{40}$ (1 to 40) and the rennet zymogen up to $\frac{1}{150}$. In carcinoma the ferment may be entirely absent, and the zymogen is commonly reduced as low as $\frac{1}{40}$ or $\frac{1}{13}$.

Acetic and butyric acids are commonly present in stagnating contents. The proteoses and, perhaps, peptone are present sometimes in excess, owing to impaired absorption. Starch digestion is usually retarded or entirely checked by high acidity, but if the acidity is low

it is not affected; in cachectic patients, however, the saliva is of poor quality, and is therefore relatively inactive.

Complications.—The complications are usually in the nature of secondary carcinomatous deposits in other parts, although any intercurrent disease may perchance occur. Involvement of, or pressure upon, the biliary ducts by the new growth or impacted gall stones, or duodenitis may cause jaundice. The lymphatic glands, liver, peritoneum, or pancreas may be the seat of metastatic growths or be involved by direct extension of the gastric neoplasm. Peritonitis, pleuritis, or, rarely, pericarditis may occur. Venous thrombosis may take place in the lower, less frequently in the upper, extremities. Metastatic nodules may develop in the brain and cause sudden death. Gastrectasia and chronic catarrhal gastritis, coupled, perhaps, with some nervous disturbance of the stomach, are quite constant results of the carcinoma. Perforation from deep ulcer may occur into the peritoneal or thoracic cavities, the transverse colon, or the small intestine.

Diagnosis.—In the presence of many or all of the symptoms and physical signs of gastric carcinoma there is usually no difficulty in making a diagnosis. Many cases are atypical; for instance, vomiting, pain, hæmatemesis, or other symptoms may be absent; there may be no tumor or dilatation; weight and strength may be fairly well maintained; therefore some cases are difficult of diagnosis, and in these it may not be possible to come to more than a provisional conclusion. The cardinal points upon which to base a diagnosis are the age, progressive emaciation, cachexia, vomiting with or without hemorrhage, obstinate constipation, and the detection of a tumor with, perhaps, gastrectasia, absence of HCl, presence of lactic acid, the finding of abundant lactic-acid-forming micro-organisms and the "faden" bacillus. Care should be exercised in differentiating the disease from gastric and duodenal ulcers, chronic gastritis, biliary lithiasis, and carcinoma of contiguous organs.

Prognosis.—Carcinoma ventriculi is incurable by medical means, but the possibility of total extirpation of the new growth not only still remains a hope, but in the future may be more frequently realized than in the past. In 1881, Billroth performed a successful pylorectomy, and since that time the operation has been done several times with success, but the larger percentage die. If the diagnosis could be made earlier, the disease might be eradicated by surgical means more frequently than has been the case heretofore. Although life may rarely be saved, it may be prolonged by surgical intervention, as in the cases of pyloric carcinomata in which gastro-enterostomy is performed. Death may occur suddenly from perforation into the peritoneal or thoracic cavities, profuse gastrorrhagia, or from metastasis into the brain.

Treatment.—Although no medical treatment yet known cures the disease, much may be done to give the patient comfort. If the disease is located at the pylorus and has progressed too far to permit of pylorectomy, gastro-enterostomy frequently prolongs life, stops the vomiting, restores appetite, flesh, and strength, overcomes constipation, and may be warmly recommended to relieve persistent food stasis. When the new growth is situated at the cardia, giving rise to obstruction, with consequent dysphagia, regurgitation, and starvation, a gastric fistula should be established through which the patient may be fed.

Aside from surgical measures, the treatment is symptomatic and palliative. Vomiting may be lessened by the administration of shaved ice, iced carbonated waters, iced champagne, cocaine, hydrocyanic acid, carbolic acid, creasote, cerium oxalate, picrotoxin or morphine. If there is gastrectasia, lavage is the best measure for controlling the vomiting. Pain may be relieved by large doses of chloral or morphine. Pyrosis and eructation are best overcome by lavage, but may be lessened by sodium bicarbonate or calcined magnesia, menthol, resorcin, ichthyol, benzonaphthol, sodium hyposulphite, carbolic acid, sodium salicylate, creasote, hydrogen dioxide, potassium permanganate, or charcoal. Since Friedreich recommended condurango in 1874 it has been used with varying results. Leube and Riegel regard it as a mere stomachic, and that is the consensus of opinion concerning it at the present time. In the experience of some it stimulates the appetite and lessens vomiting and gastric distress. Ordinarily, the fluid extract is used, but Friedreich advised half-ounce doses of the decoction, made by macerating half an ounce of the bark for twelve hours in twelve ounces of water and then boiling down to six ounces.

The diet should consist largely of liquid and semi-solid foods, especially when pyloric stenosis prevents the passage of large fragments of solid food. Peptonized milk, given in four or eight ounce portions every two to four hours, often agrees admirably when other foods are vomited or cause distress. Beef-juice, clam-juice, scraped beef, syntonin made by adding 56 minims of dilute hydrochloric acid to an ounce of egg albumen, and allowing the mixture to stand in a warm water bath for half an hour; eggs raw or very soft boiled in the manner described (see page 113); stale bread, zwieback, toast, "saltines," mealy baked potatoes, thoroughly cooked rice, fruit-juices, tea, coffee, and cocoa may be allowed. If no pyloric obstruction is present, beefsteak, roast beef, lamb chops, roast lamb, tender breast of chicken, bluefish, weakfish, mackerel, trout, bass, or other delicate fish, tender cauliflower, beets, turnips, lettuce, and other succulent vegetables—in fact, a selected mixed diet—are quite permissible. Sometimes feeding by the stomach is unsatisfactory, and eventually resort must be had to rectal alimentation.

Hydrochloric acid is one of the most valuable remedies in this affection. When it is absent from the stomach contents it should be given in liberal and repeated doses after meals, as much as a drachm of the dilute acid, perhaps, being taken in divided doses after each meal. It sometimes causes soreness and distress, however, and it cannot be given indiscriminately in all cases.

Lavage gives distinct relief if there is dilatation. It should be practised at night two or three times a week, the stomach being left empty until morning. It checks the vomiting, lessens gastric weight, fulness, and distress, gives the patient a feeling of well-being that conduces to sleep, and it not infrequently overcomes the constipation. If not given at night, lavage should be practised in the morning before breakfast, in order that remaining stomach contents may be removed.

Constipation should be treated by colon flushing, saline cathartics, cascara, aloin, or other mild laxatives, avoiding the employment of harsh drastic purgatives.

Non-carcinomatous Gastric Tumors and Foreign Bodies.

Benign tumors in the stomach are very rare, and may not give rise to any symptoms other than those accompanying nervous dyspepsia, unless they happen to cause obstruction of the pylorus or cardia. Mucous (adenomatous) polypi, formed by hyperplasia of the mucous membrane, are the most common of the benign tumors. They have been found at autopsy scattered over the interior of the stomach, as many as one hundred and fifty being present in Leudet's case. They may also, though rarely, appear as submucous growths. Fibromata, papillomata, lymphomata, lipomata, and cysts may also be found. Sarcoma may occur in the stomach, Welch having seen two cases of lymphosarcoma secondary to that of the retro-peritoneal glands. In the Vienna clinic a case of gastric myoma was seen in 1874, and myosarcomata have also been observed.

Occasionally foreign bodies in the stomach simulate neoplasms, as for instance gastroliths composed of shellac with food detritus, as in Best's case, or food concretions, as in Kooyker's, in which the gastrolith weighed over 800 grammes and caused death.

Manasse, Friedländer, Langenbuch, and others have also observed cases of shellac concretion.

Hair-balls in the stomach may attain enormous proportions, as in a case reported by W. L. Allen of Davenport, Iowa, in which a hair-ball 17 inches long, including the part that extended into the duodenum, and $8\frac{1}{2}$ inches in circumference at the greater curvature, was successfully removed by gastrotomy in a girl aged sixteen years. Von Bollinger in 1891 reported a similar large hair-ball found at autopsy in a girl of the same age.

In the insane many foreign bodies are sometimes found in the stomach. Craig of Albany in 1892 reported the case of an insane woman in whose stomach were found one hundred and twenty articles, including pins, needles, screws, nails, etc. Judson B. Andrews and Bastian reported somewhat similar cases. Foreign bodies in the stomach have been demonstrated by means of the *x*-rays, and subsequently successfully removed.

GASTRORRHAGIA AND HÆMATEMESIS.

Bleeding from the stomach is shown by hæmatemesis, by the presence of blood in the fluid returned through the stomach tube, or by melæna. Hæmatemesis often occurs without gastrorrhagia, in which case the blood may arise in the œsophagus, mouth, or air passages, as, for instance, in hæmoptysis or epistaxis, and, having been swallowed, is subsequently vomited. Exceptionally blood may find its way into the stomach through a patulous pylorus when hemorrhage into the intestine occurs. Gastrorrhagia may result from local disease of the stomach or from constitutional diseases. Among the latter are to be mentioned leucæmia, pernicious anæmia, scurvy, hæmophilia, Bright's disease, malaria, and some of the other acute infections. Gastrorrhagia sometimes

appears in neurotic patients from unknown causes. In females it is supposed to depend on vicarious menstruation. Although this has been seriously questioned by many observers, we have seen two instances in which hæmatemesis occurred repeatedly at the menstrual epoch and at no other time. One case was that of a young girl who suffered from hystero-epilepsy particularly at the time of her menstrual periods. Often during these attacks she vomited blood in considerable quantity. She was relieved by withdrawing a few ounces of blood from the arm on the approach of the period.

Congestion of the stomach following portal obstruction is a common cause of gastrorrhagia, and the obstruction may arise from general venous stasis produced by cardiac or pulmonary disease, or it may follow cirrhosis of the liver or portal thrombosis. The causes of local hemorrhage in the order of their importance are—first, peptic ulcer; second, portal obstruction; third, carcinoma; fourth, gastritis; fifth, erosion. Besides these, gastrorrhagia occasionally, though rarely, results from aneurysm opening into the stomach or from ulceration through the stomach wall from some process arising outside of the organ.

Symptoms.—Save when blood is brought up with the stomach contents or when it appears in the form of melæna there are no symptoms of gastrorrhagia when it is slight. When it is severe, in addition to the symptoms above mentioned there will be found present those phenomena common to all extensive hemorrhages. There occur faintness, or even syncope, accompanied or followed by vomiting of blood. There are coldness of the surface and sweating, especially of the extremities, depression in temperature, dilatation of the pupils, a sighing respiration, a small, weak, often thready pulse, yawning and stretching of the body, and occasionally convulsive movements. Later on blood appears in the stools, sometimes copiously; it has a dark, chocolate-like appearance, and when accompanied by fecal matter is thoroughly blended with it, the character of the stool thus differing from the discharges that occur when the hemorrhage is in the lower part of the intestine. The vomited blood may vary in appearance according to the extent of the bleeding and the length of time that the blood has remained in the stomach.

Diagnosis.—There is rarely much difficulty in discovering the source of the blood in hæmatemesis. The history of the case will usually enable one to exclude bleeding from the nose and throat. When this is not sufficient a careful examination may determine the matter. Exceptionally there is some embarrassment in reaching a conclusion until time has elapsed for further observation. We have seen cases treated for gastrorrhagia supposed to depend upon peptic ulcer when the bleeding arose from unsuspected pulmonary lesions. Large hemorrhages from the stomach generally arise from gastric ulcer or from cirrhosis of the liver. When from ulcer, the appearance of the vomited blood will be bright red and fluid, provided it has not been long retained in the stomach. If retained, it may be somewhat clotted and dark. When hemorrhage occurs from cirrhosis of the liver, the blood is dark, even if vomited immediately, and is often very abundant. It is rare for extensive hemorrhage to occur in cancer of the stomach,

although such an event may happen when a large vessel is opened by ulceration. Generally the amount of blood is small, having a dark granular, "coffee-ground" appearance, and the hæmatemesis is apt to be frequent. In gastritis the hemorrhage is small and is accompanied with mucus or stomach contents. The same is true of erosion.

Prognosis.—Gastrorrhagia may end in death, although experience shows that its course is more favorable than would naturally be expected. The fatal cases that we have seen were secondary to hepatic cirrhosis. With very rare exceptions the fatal cases depend upon cirrhosis of the liver, gastric ulcer, or portal thrombosis.

Treatment.—The patient should be placed in bed, kept perfectly at rest, and isolated from all save the necessary attendants. Mental and bodily excitement are alike harmful, and therefore appropriate doses of morphine should be given hypodermically. In pursuance of the same plan, food and medicine should not be allowed to enter the stomach for several days after the cessation of the hemorrhage. For the relief of thirst water may be introduced *per rectum*, and at intervals of eight to twelve hours a nutrient enema is advised. When the patient is in syncope and rallies slowly alcoholic or other stimulants may be introduced per rectum, but there is danger in their use, and they must be abandoned as soon as reaction is established. The aqueous extract of ergot or ergotine should be employed hypodermically, and an ice bag applied over the epigastrium. The administration of astringents and other hæmostatic drugs is generally worse than useless, as they fail to control the hemorrhage and they excite vomiting, an event always to be dreaded in gastrorrhagia. Antipyrine is said to have been effectual in some cases.

DILATATION OF THE STOMACH; OTHER DEFORMITIES OF THE STOMACH; DISPLACEMENTS OF THE STOMACH.

The size as well as the muscular power of the stomach varies in different individuals. When large, but capable of emptying itself properly, the condition is termed megastria; when of normal size, yet incapable of emptying itself in due time, gastric insufficiency is present. When, however, the stomach is larger than normal, holding more than from 1500 c.c. to 1700 c.c., and allows food stagnation, true gastrectasia may be said to exist. There are instances in which the lower border of the stomach is from two to three inches below the umbilicus, yet the motor power is sufficient most of the time, there being, however, periods of deficient motility with more or less consequent food stasis.

Etiology.—The causes of gastrectasia may be considered under the following headings: (*a*) obstruction of the pylorus or adjacent parts of the stomach or duodenum; (*b*) motor insufficiency of the stomach.

Carcinoma is the most common cause of pyloric stenosis; medullary and scirrhus are the most frequent forms, the former often growing

rapidly and occluding the pyloric orifice by direct encroachment, or an irregular fungoid mass may project into the orifice and plug it in a cork-like manner. This form of cancer may involve the pylorus without causing extensive gastrectasia, owing to its tendency to ulceration, by which process the lumen of the pylorus may be kept tolerably free most of the time. Stasis of the gastric contents may be more or less pronounced for a few days or weeks, when quite suddenly considerable quantities of clotted blood with fragments of the neoplasm are vomited or washed away, and the food passes into the duodenum with tolerable freedom for some time thereafter. We have a case under observation at the present time that illustrates this occurrence. Scirrhus, being slower in its development, and often causing annular constriction at the pylorus, offers a constantly increasing obstruction to the onward passage of the gastric contents. At first the lumen of the pylorus is only slightly narrowed, and gastric muscular hypertrophy compensates sufficiently to prevent food stasis. Owing to the progressive nature of the disease, the pyloric orifice grows steadily narrower, and the motor power of the stomach is, sooner or later, no longer sufficient to overcome the obstacle. Then dilatation begins, and at first may be slight because of the accompanying muscular hypertrophy, that is yet able to empty the stomach if time enough is allowed and if the ingesta is small in amount, but not in the normal time even after a limited quantity of food. Scarcely two cases are exactly alike in the degree of pyloric stenosis and the rapidity with which the stomach dilates, some cases requiring many months, others only a few weeks, for the establishment of marked gastrectasia. Finally, when the pyloric orifice will allow but a minute quantity of gastric contents to pass, gastric motion is of little avail, and, whereas in the earlier stages of the disease active and forcible peristalsis was present, now the stomach gives up the fight and lies almost motionless, distended with gas and stagnating contents.

The cicatricial contraction of an ulcer occasions dilatation in young and middle-aged adults, whereas malignant disease occurs usually after thirty-five years of age. The degree of stenosis varies as to location, size, depth, and surrounding inflammation of the ulcer. There is usually a history of long-standing stomach trouble; characteristic symptoms of ulcer may be elicited. It is very rare for annular constriction to occur from this cause. The pyloric orifice may be only slightly narrowed by a healing ulcer, the tissues about the orifice being puckered so as to produce a moderate though persistent obstruction with consequent ischochymia. In such cases compensatory hypertrophy of the muscularis may overcome the obstruction for some years, as in analogous conditions of the heart. As a rule, the more complete the stenosis in benign conditions the more extensive is the gastrectasia, although slight occlusion may be accompanied by great dilatation. In addition to these two common causes of pyloric obstruction, others less frequent, and some of extreme rarity, may be mentioned.

A polypoid excrescence of the gastric mucosa near the pylorus may be pushed into the orifice whenever the stomach is filled, and thus cause obstruction. Hyperplasia of the mucosa and underlying tissues at the pylorus may lead to some occlusion. Torsion of the duodenum near the stomach from gastroptosis or from a vertical position of the organ is

said to cause gastrectasia. Congenital pyloric stenosis is a very rare etiologic factor. Pressure upon the duodenum, the pylorus, or the stomach near the pylorus may result from tumor of the liver, pancreas, or mesentery, from floating kidney, or from constricting bands from peritonitis. Ewald mentions a case in which a diverticulum of the duodenum in its first part narrowed the pyloric orifice by pressure, owing to its distention with duodenal contents. Spastic contraction of the pylorus is considered by some observers to account for gastrectasia in a few instances. It probably plays some part in the causation, and may be excited by purely nervous influences or by irritating gastric contents, hyperchlorhydria, erosion, or ulcer. Too much importance should not, however, be attributed to spasm as a cause of gastrectasia, as it is largely hypothetical. In all forms of pyloric stenosis the motor power of the stomach is an important factor in determining the extent to which dilatation will develop. The conditions favoring muscular hypertrophy are good innervation, plentiful supply of well-oxygenated blood, absence of inflammatory or degenerative affections of the muscularis or mucosa, vigorous muscular tone, and good general nutrition. In proportion as these factors exist in a case will hypertrophy develop and continue compensatory. As in cardiac lesions, there eventually comes a time when from acute or chronic disease, such as typhoid fever or chronic tuberculosis, compensation fails and gastrectasia is brought about.

Motor insufficiency of the stomach or atony leads to more or less dilatation in a larger number of cases than is popularly supposed. The gastrectasia thus resulting, however, is somewhat irregular as to its extent, persistence, and the degree of food stasis it induces. The lower border of the stomach may be found three or four inches below the umbilicus, with or without an associated gastroptosis, and yet the motor power be sufficient to empty the stomach normally. On the other hand, food stasis may occur at times, but is not so marked nor so persistent as in the case of pyloric stenosis. Nervous symptoms are usually prominent in these cases, such as hemicrania, intercostal neuralgia, nervous belching, insomnia, cold hands and feet, and numbness in various parts of the body; and one or several causes of general nervous disturbance may be operative, as, for instance, worry, overwork, continued nerve tire from late hours, with constant excitement, eye-strain, or pelvic disease. Anæmia, tuberculosis, diabetes, or any chronic or exhausting disease is likely to lead to more or less gastrectasia, owing to poor nutrition of the stomach, which is frequently overtaxed when the appetite is increased. The muscular coat of the stomach may be weakened by chronic catarrhal gastritis or by an unusually large area of ulceration, sclerosis, fatty, amyloid, or colloid degeneration.

Foreign bodies, such as hair-balls, coins, or gastroliths, may cause gastrectasia, both by weakening the muscular coat and obstructing the pyloric orifice.

Finally, gastrectasia is frequently caused by daily over-distention of the stomach, as in beer-drinkers, gourmands, or in those who eat excessive quantities of coarse, indigestible food that cannot readily pass the pylorus. Gastrectasia occurs most frequently in middle and advanced life, as the common causes are operative during that period. Stenotic dilatation is very rare in childhood, while the atonic form and that re-

sulting from over-feeding, improper feeding, and catarrhal gastritis is not uncommonly seen in children. We have observed a number of cases of gastrectasia in boys from two to twelve years of age, who recovered under proper dietetic management. The lower border of the stomach in these cases was from two to four inches below the umbilicus.

Pathological Anatomy.—The degree of dilatation may be only moderate, or the organ may be so enormously enlarged as to fill a large part of the abdominal cavity, pressing upon and displacing other organs. Sometimes the dilatation exists in a pouched form, the fundus being the portion to dilate most readily. The capacity of the stomach may be enormous; Welch mentions Blumenthal's case, in which sixteen pounds were vomited, and Leube a case in which it held thirteen pounds. We have observed a few cases in which the stomach contained eight pounds, and one in which it held ten pounds. The walls may be thick or thin; in very marked dilatation they are usually thin from stretching and atrophy, whereas in stenotic cases muscular hypertrophy not infrequently leads to thickening.

Fatty or colloid degeneration may be found, or connective-tissue increase with some round cell infiltration may be present. The mucosa is frequently in a chronic catarrhal condition, in some areas thickened, in others thinned. Atrophy of the glands may be observed. The special pathological condition causative of gastrectasia, such as carcinoma or cicatricial constriction, constitutes a part of the morbid anatomy of the affection.

Symptoms.—Occasionally acute dilatation of the stomach occurs, and in the reported cases sudden vomiting was noticed which persisted for several days. At the outset in these cases large quantities are usually vomited; later, emesis is less copious, and finally ceases. Acute dilatation may be precipitated by overeating with an exhausted gastric innervation.

Vomiting is one of the chief symptoms of gastrectasia. In cases of pyloric carcinoma it may occur early, but usually is delayed until food stagnation is present. At first vomiting may occur at long intervals, perhaps one or more months, but each time it is noticeably copious. It usually affords great relief from the pressure, distention, weight, pain, and nausea preceding it. As dilatation increases vomiting of large amounts of fermenting, sour, foul-smelling contents becomes more frequent, until it may occur every day. In some cases, however, emesis is not frequent, even in the advanced stages of the disease. In other cases regurgitation (water-brash), accompanied by a free flow of saliva, constitutes the chief gastric symptom. In cases of atonic gastrectasia vomiting is not so common as in stenotic dilatation, and is sometimes altogether absent. Pain is an inconstant symptom in carcinomatous cases, but is more common in cases of cicatrical ulceration; it is usually absent in atony. Sensation of weight, distress, fulness, burning, and soreness in the epigastrium are often complained of in all forms of dilatation.

Eructation is of common occurrence, and the gases raised from the stomach may be offensive in odor. H_2S is sometimes belched in benign and malignant stenosis, being more frequent in the former than in the latter. In rare instances the gases have been inflammatory, being

partly composed of marsh gas. If there is no pyloric stenosis, the belching is often of a nervous character, the gas being odorless. Anorexia is common in malignant cases, but we have seen an insatiable appetite in cases consequent upon gastric ulcer; the appetite is often capricious in functional gastrectasia.

Constipation is usually obstinate, especially with pyloric stenosis. Ordinary cathartics soon lose their effect, and enemata are resorted to; the stools are scanty and offensive.

Emaciation is sometimes extreme, but, contrariwise, flesh and strength may be fairly well maintained; in malignant cases loss of flesh always occurs eventually. The most marked emaciation we ever observed occurred in a man about thirty-eight years of age, the lower border of whose stomach reached nearly to the pubes. Food stagnation was not marked nor were gastric symptoms prominent. The patient thought he had pulmonary tuberculosis, and sought advice as to change of climate. Under lavage, intra-gastric faradization, and careful regulation of the diet he gained forty-seven pounds in ten weeks, and the lower border of the stomach was then found at the umbilicus.

Anæmia of some degree always occurs, but is, of course, of a more severe grade in malignant cases. Ordinarily, secondary chlorosis is found, although a pernicious type of anæmia may be present. Usually the hæmoglobin is reduced; the red cells number from 2,500,000 to 4,000,000; a few macrocytes and microcytes and poikilocytes are found; the red cells are pale; leucocytosis may or may not be present. This picture may be modified by ulceration, which causes leucocytosis, or by the appearance of anæmia of a pernicious type, as occurs late in the disease.

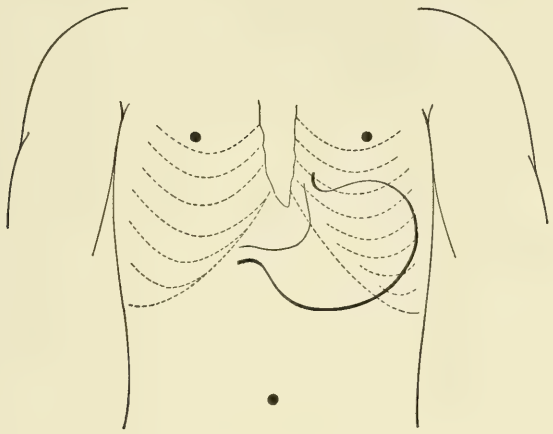
Vertigo, numbness of the extremities, insomnia, and a variety of nervous symptoms may be present. Tetany, first mentioned by Kussmaul, is occasionally seen in gastrectasia, sometimes occurring just after the use of the stomach tube. The urine is usually scanty, neutral or alkaline in reaction; it may be albuminous, and indicanuria is not infrequent; the urinary solids are usually low; peptonuria or acetonuria may be found.

Examination of the Abdomen.—By inspection of the abdomen with the patient lying on the back the stomach may be seen bulging out below the umbilicus if it is distended with food and gas. Peristaltic waves may be seen running toward the pylorus or reversed in the direction of the cardia, these being visible only when motion is yet fairly vigorous, often disappearing late in the disease. In many cases inspection yields negative results. After the stomach is emptied a pyloric tumor may be seen if the abdominal parietes are thin and relaxed. Gastrectasia may be demonstrated by the *x*-ray after the manner described by C. L. Leonard of Philadelphia, in which a bismuth mixture is introduced into the stomach to cause a shadow.

Palpation.—Tumors of the pylorus may be felt through the abdominal walls; frequently a tumor is more easily palpated with the stomach empty. A pyloric tumor may be felt in the epigastrium midway between the ensiform cartilage and the umbilicus or at the umbilicus, to the left or right of the median line in either of these positions, or between the umbilicus and the pubes, or, very rarely, just above the pubes. Leube

proposed the palpation of the tip of a stiff tube through the abdominal parietes; if the end can be felt below the umbilicus, it is evidence of gastrectasia, atony, or gastroptosis. Ewald thinks it impossible to feel

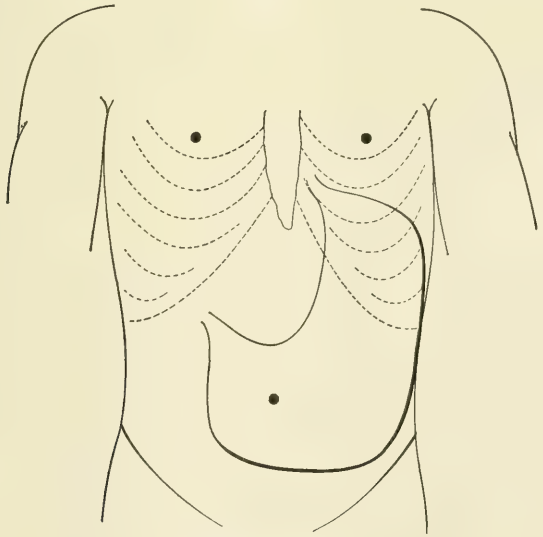
FIG. 4.



Normal stomach.

the tip of the tube through thick or tense abdominal walls; furthermore, it may engage in the rugæ of the stomach walls and not reach the lower border.

FIG. 5.



Dilated stomach.

Percussion.—By percussion tympanitic resonance is produced over a large area extending from the left free border of the ribs down as far as several inches below the umbilicus, sometimes as low as the pubes. The

fluid contents sink to the most dependent portion of the stomach, and in the upright position dulness may be heard below and resonance above. The position of the patient may be further changed and the gastric area examined. Sometimes it is difficult to distinguish between intestinal and gastric resonance, and then the stomach should be inflated either by Frerich's method of allowing the patient to drink separate solutions of citric or tartaric acid and sodium bicarbonate, thereby generating carbon-dioxide gas in the stomach, which if dilated will bulge out below the umbilicus, sometimes as low as the pubes, and its clear tympanitic percussion note enables the examiner to map out its boundaries without difficulty. In some instances the gas escapes into the duodenum or is belched as fast as it is evolved, and then a tube may be introduced into the stomach and air pumped in by an attached double bulb apparatus. In order to ensure greater accuracy the colon may be filled with fluid while the stomach is distended with air, and the differentiation thus made easier and more positive. Or the colon may be filled with air and the stomach with water, percussion being then practised. It is interesting to note that the normal stomach frequently fills upward instead of downward, as pointed out by Jaschtschenko and confirmed by Boardman Reed; that is, if successive glasses of water are taken, the dulness does not extend lower, but increases upward, owing no doubt to good gastric tone and strong intra-abdominal pressure. If, however, gastric atony or dilatation be present, the first glass of water usually causes splashing and dulness at or below the umbilicus; the second glass causes dulness still lower; while the third and fourth glasses depress the lower border yet farther. This practically constitutes Dehio's method of ascertaining the lower border of the stomach, which, in detail, consists in allowing the patient in the upright position and with an empty stomach to drink one litre of water in four portions (about a half-pint in each portion), and ascertaining the lower border by percussion after each portion is taken. Another method of determining the size and capacity of the stomach consists in filling it through a tube, and then measuring the water that is drawn off or introduced; but, as Ewald says, "When is it full?" We only have the statement of the patient to guide us. Schreiber used a thin rubber bag attached to the end of a stomach tube, and filled this with fluid or air, but, aside from its therapeutic use as a hot-water bag in the stomach and its use attached to a manometer for measuring gastric motility and intra-gastric pressure, it has a limited value as a means of determining the size of a dilated stomach.

Auscultation.—Gastric splashing (succussion, clapotement, clapotage), elicited by repeated dippings with the fingers over the stomach, may be heard usually with the unaided ear. In examining for this the hands should be warm and laid flat upon the abdomen, the walls of which should be relaxed; then the fingers should quickly dip and shake the stomach, thus causing a splashing sound. In health this may be heard, but is not so easily elicited, nor is it below a line about one inch above the umbilicus. In gastric atony or gastrectasia it is a very common sign, sometimes the succussion being loud enough to be heard several feet away. Like percussion-tympany, splashing may occur as low as the pubes. The patient is frequently able to produce the splashing sound by alternate sudden contraction and relaxation of the diaphragmatic

and abdominal muscles. Occasionally colonic splashing is elicited, and may be confused with that occurring in the stomach. Stethoscopic auscultation, combined with percussion, may assist in determining the lower border of the stomach. Rosenbach's method, of pouring successive quantities of water into the stomach and then listening with the stethoscope for air forced through the tube by a bulb to bubble upon the surface of the water, may assist in estimating the size of the stomach, although in our experience it has been of little value. As the air bubbles break upon the surface of the water in the stomach they make a loud metallic, bubbling sound. Einhorn's gastrodiaphane is very valuable in locating the lower border of the stomach. In our cases we have been uniformly successful with this instrument in demonstrating not only the size of the stomach but carcinoma involving the anterior wall.

Examination of the stomach contents yields different results in different cases according to the cause and extent of the dilatation. The stomach tube should be introduced from twenty-six to twenty-eight inches from the teeth in order to siphon out the contents from the most dependent portion of the stomach; usually, however, when the tube reaches twenty-two inches or thereabouts, the contents pour out copiously, consisting of dark or brownish, semi-fluid, foul, yeasty-smelling, sometimes foaming material quite characteristic of food stagnation. Foods may be present that were eaten several days or even weeks before; especially seeds are likely to remain in the stomach. Usually considerable ropy, tenacious mucus is present, holding food particles in its meshes; if it is not found at the first withdrawal, it is often seen in the wash water as repeated flushings are made.

Free hydrochloric acid is absent, as a rule, in gastrectasia secondary to carcinomatous pyloric stenosis, although it may be present either in traces or in normal quantities. In 3 cases of pyloric carcinoma observed during the past year we found in 1 free HCl .05 per cent. total acidity 45; in another HCl .10 per cent., total acidity 85; and in the third HCl .14 per cent., total acidity 100. Lactic acid is usually present in the malignant cases excepting those having free HCl, in which it is absent as a rule.

With non-malignant stenosis HCl is usually present, sometimes in large quantities. It may, however, be persistently absent and the total acidity below normal; lactic acid is nearly always absent in the presence of free HCl, but it is quite commonly present on ordinary diet in cases without HCl. Acetic and butyric acids are often present, and alcoholic fermentation occasionally occurs. The proteoses and peptone are present more or less abundantly, unless from atrophy of the gastric glands the pepsin and HCl are totally absent.

Rennet ferment and rennet zymogen are present with free HCl, but greatly diminished in malignant cases or when there is atrophy of the glands. Starch digestion varies with the acidity of the stomach and the amount of mastication and insalivation amylaceous foods are subjected to.

Microscopic examination often reveals many forms of bacteria, the chief being those giving rise to lactic and butyric acid fermentation, besides putrefactive organisms. Sarcinæ ventriculi are considered by

Boas more common in benign than in malignant stenosis, although they are found in the latter, and yeast cells are frequently present.

In some cases of achylia gastrica, with gastrectasia, fermentation and putrefaction are not as marked as in the other forms of dilatation; indeed, symptoms in these cases may be slight or absent, and the acidity is commonly not over 4 or 5 per cent., notwithstanding considerable food stasis.

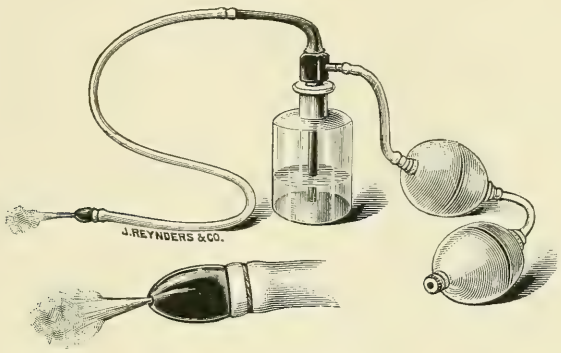
Prognosis.—The prognosis in cancerous stenosis is very grave. If resection of the pylorus could be made very early, perhaps lives might be saved. Gastro-enterostomy prolongs life sometimes more than a year, the patients being relieved of vomiting, gaining weight and strength, and being comparatively comfortable.

In benign stenosis the prognosis is not serious, so far as life is concerned, but is doubtful as to complete recovery, except in case of successful surgical intervention. Care in diet and great perseverance along the line of proper treatment often result in restoring gastric function, with flesh and strength. In functional dilatation the outlook is favorable, provided appropriate treatment be thoroughly carried out.

Treatment.—Lavage is the most effectual therapeutic measure at our command in the treatment of gastrectasia. It unloads the overdistended stomach, withdraws toxins, cleanses the irritated and inflamed mucous membrane, checks vomiting, relieves nausea, distress, vertigo, headache, or a variety of toxic symptoms that may be present. It should be practised thoroughly, repeated flushings being made until the wash water returns clear. Solutions of boric acid, soda, common salt, borax, or Carlsbad water may be used. Potassium permanganate should be used in 1 or 2 per cent. solution near the completion of the treatment, especially in cases with absence of free hydrochloric acid and foul-smelling contents. For the catarrhal condition so frequently accompanying dilatation argentum nitrate is an excellent remedy. We use a solution of one or two grains in eight ounces of distilled water, pouring it through the tube after the stomach is clean and all saline fluids have been removed; it is left there for a few moments and then siphoned out; a small portion remaining is not washed away. This solution may be used with benefit two or three times a week. In cases of benign stenosis or spastic contraction of the pylorus and superacidity one or two drachms of bismuth subnitrate or subcarbonate, suspended in a few ounces of mucilage of althea, tragacanth, or acacia, or mixed with water, may be poured through the tube into the cleansed stomach and left there, or a drachm or two of the aqueous fluid extract of hydrastis may be used with the bismuth. In associated painful conditions menthol or oil of gaultheria vapor may be used in the stomach by means of a double tube vaporizer, which allows the vapor to escape, yet maintains a moderate intra-gastric pressure; this measure seems to act as an analgesic and slight motor stimulant. The best results are obtained when lavage is practised at night and the stomach is allowed to remain empty until morning. Especially is this true in benign pyloric stenosis, whereas in cancerous stenosis lavage should be practised in the morning a half to one hour before breakfast, although occasionally it may be resorted to at night. The stomach douche should not be used too frequently; there is, however, no rule that can be

applied to all cases. Many of our cases have gained flesh while having lavage and intra-gastric faradization from four to six evenings a week, while we find it best to treat other cases only two or three times a week or less frequently. The stomach should not be emptied until ten or eleven o'clock at night, in order to avoid robbing the patient of nutriment. Faradic electricity applied by the intra-gastric method is a valuable adjuvant to lavage, and it may be applied for five or ten minutes after the stomach is cleansed, and of a strength sufficient to contract the abdominal muscles. If secretion is depressed or gastralgia

Fig. 6.



Einhorn's gastric vaporizer.

is associated, the galvanic current, from five to twenty milliampères, may be used with the anode inside the stomach. While it is true, as Boas says, that lavage should not be used as a routine treatment in simple gastric atony, yet when atony reaches a stage allowing food stasis for twelve hours or longer, lavage and intra-gastric faradization result in positive benefit. A few treatments only are required in these cases, as a rule, before gastric motility is greatly improved.

The diet should consist mostly of solid food, properly cooked, except in some cases of carcinomatous stenosis, in which practically no food passes the pylorus; in these peptonized milk, raw egg albumen, with hydrochloric acid, meat powders, and finely comminuted starches, given in small quantities at frequent intervals, afford more nutriment with less discomfort than do solid foods. In benign stenosis with an abundance of free HCl albuminoids should comprise the larger portion of the food. Meats, such as beef and lamb, should be cut into very small pieces at table or chopped or scraped and served in the form of broiled meat balls; eggs should be taken raw or very soft boiled or poached; the white should not be hard; stale bread, toast, zwieback, the crust of rolls, water-wafers, or Graham biscuits may be eaten. Milk plain, peptonized, or with one-third lime water or Vichy may be taken in moderate quantities between meals to allay thirst in the place of large draughts of water, which by its weight embarrasses motility.

In cases presenting an absence of gastric secretion the food should consist largely of amylaceous substances very finely comminuted and thoroughly masticated, and HCl may be freely administered in these

cases (see page 120). The bowels should be kept open by mild cathartics rather than strong and irritating drugs. Aloin, podophyllin, or cascara may be used separately or in combination. Largely diluted salines should be avoided, as they fill the stomach without being effectual. Pil. colocynth. comp. or pil. cath. comp., veg. imp., U. S. P., is occasionally efficacious.

Colon flushing is an excellent measure in this disease, as it cleanses the colon, supplies water to the tissues, and acts as a prompt diuretic. A soft-rubber tube about the size of a small stomach tube (No. 10 or 11), thirty inches long, may be smeared with vaseline, passed twenty or more inches into the bowel, and attached to the fountain syringe, containing two quarts of warm boric-acid solution. The patient should lie on the back with the hips higher than the shoulders while the injection is being made. Medical gymnastics sometimes assist in emptying the stomach. A skilled masseur may succeed in forcing a portion of the stomach contents through the pyloric orifice by deep rhythmical manipulations from below upward and from left to right in the direction of the pylorus. Over-medication in this disease is undesirable, as the stomach is apt to be intolerant; there are, however, some remedies that seem to do good. Nux vomica is an admirable remedy in atonic dilatation; it should be given in large doses. In cases of superacidity with stenosis from cicatricial ulcer the gastric sedative composed of cerium oxalate 1 part, bismuth subcarbonate 2 parts, and light magnesium carbonate 4 parts, should be given in drachm doses, stirred in water, between meals and at bedtime. An illustrative case of this kind may be cited: A young lady giving a history like that of gastric ulcer presented herself with gastrectasia, emaciation, epigastric pain and tenderness; the lower border of the stomach was four inches below the umbilicus. She was taught to give herself lavage, which she did admirably at 10 P. M. three nights a week, and was given the gastric sedative between meals and at bedtime after lavage. The diet was chiefly albuminoid, and fluids were restricted by the stomach, but given by large enemata. The symptoms all abated; insomnia, which had been troublesome, disappeared; in three months she gained thirty-nine pounds, and the lower border of the stomach rose to the umbilical level. Ordinary antiseptics, such as sodium hyposulphite, resorcin, potassium permanganate, benzonaphthol, zinc sulphocarbolate, and others are not of much value. In atonic dilatation general and intra-gastric electricity, tonic hydrotherapy, and pleasurable exercise in the sunlight and fresh air are very beneficial.

The surgical treatment of stenotic gastrectasia is important, and may consist of pylorectomy, gastro-enterostomy, pyloroplasty, Loreta's divulsion operation, or taking a tuck in the walls of the stomach, thus reducing its size (gastrorrhaphy). The best results are often obtained in benign stenosis, but gastro-enterostomy in cancerous cases prolongs life and alleviates the suffering, and is to be advised if the patient is not too weak or old and feeble. Einhorn speaks highly of Heinecke-Mikulicz pyloroplasty in benign stenosis, and has had a number of cases cured by it. This operation was done in one of our cases, and was very successful. Gastro-enterostomy or any operation that will permit the stomach contents to pass into the small intestine should be done, and in that way vomiting will be checked, weight and strength will be gained,

constipation will usually disappear, and good health may be re-established. We wish to emphasize the importance of the surgical treatment of pyloric stenosis, especially of the benign kind, in which pylorectomy has been successful in 54 per cent., gastro-enterostomy in 71 per cent., pyloroplasty in 77.4 per cent., and digital divulsion in 59 per cent.

Gastroptosis.—DEFINITION.—A downward displacement of the stomach associated with enteroptosis, nephroptosis, and sometimes with prolapse of the liver, spleen, pancreas, and the pelvic organs.

ETIOLOGY.—We are indebted to Glénard for a proper understanding of enteroptosis, although, as long ago as 1864, Dietel described floating kidney and its manifestations, and Cruveilhier, Virchow, and others called attention to the downward displacement of the abdominal viscera.

A short time after the publication of Glénard's paper, in 1885, Lockwood of England in his Hunterian Lectures on Hernia (1887) described the prolapsed condition of the mesentery as commonly associated with, and antecedent to, hernia, and he also emphasized the fact that there was very frequently accompanying this condition a ptosis of the flexures of the colon, as well as of the right and left kidneys. The most important causes of enteroptosis are—first, the predisposing condition of poor fixation of the abdominal viscera; second, lack of development of the abdominal muscles, causing poor intra-abdominal pressure; and, third, the wearing of corsets or other tight, unyielding garments so commonly used by women. In the abdominal cavity, contrary to the rule observed in the cranial and thoracic cavities, solidity and fixation are sacrificed to liberty of motion of the contained viscera. In a measure, this motion is essential to the proper function of the organs, but beyond certain limits, that doubtless are not the same for all individuals, there is danger that the viscera may drag anchor, as it were, and not be again readjusted. The most prominent factor in keeping these organs in place is that of strong intra-abdominal pressure, which cannot be maintained unless there be good muscular parietes, able and ready to contract whenever the viscera beneath are in danger either from without or from within. Belts and corsets not only press down the viscera, but, what is even more baneful, they cause disuse and atrophy of the abdominal muscles. Some occupations also call forth little muscular exertion in this part of the body, as, for instance, the sedentary work of the seamstress, tailor, or shoemaker, or any employment that necessitates the sitting or stooping position. W. Bruce Clarke[1] particularly calls attention to the beneficial influence of rope-hauling, as in yachting and fishing, in strengthening and developing the muscles of the abdomen.

The affection is five to six times more frequent in its occurrence in women than in men, as may be readily understood when we recall its chief causes. Besides the unwholesome effect of the conventional dress of women, childbearing is responsible in not a few cases for atonic and attenuated abdominal parietes. The pressure of the gravid uterus during the later months of pregnancy leads to stretching and wasting of the muscles.

The condition is not often found before adolescence, though instances have been cited in which it occurred in infancy and childhood. We

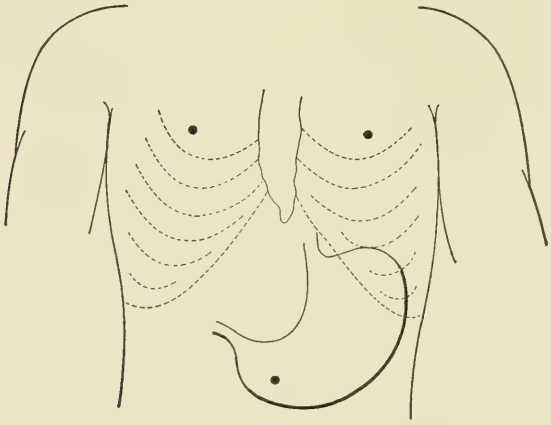
[1] *Brit. Med. Journ.*, Nov. 21, 1896.

have seen two cases in boys under ten years of age. As many cases are seen in debilitated, neurasthenic women, it appears in some to be an expression of a general neurotic state. The flabby muscular conditions often observed in neurasthenia are doubtless in a measure due to depressed nervous tone, and it will be readily admitted that abdominal relaxation may thus result and cause considerable visceral ptosis; but in the majority of cases neurasthenia is rather the result than the cause of the ptosis. Indeed, Glénard classifies the third stage as "neurasthenique."

In addition to the causes already enumerated, there should be mentioned traumatism, chronic diseases giving rise to emaciation, peritoneal adhesions making traction upon the stomach and intestines, and removal of large abdominal tumors.

Anatomical Conditions.—Glénard describes the first change in the process as downward displacement of the transverse colon near the hepatic flexure as a result of weakness of the colo-hepatic ligament. The ascending colon becomes prolapsed, and the transverse colon crosses the abdomen obliquely upward and to the left, where the firmer gastro-colic ligament usually holds the splenic flexure in proper position. The stomach occupies a position allowing its lower border to reach below the umbilicus, while its lesser curvature lies between the ensiform cartilage

Fig. 7.



Gastroptosis.

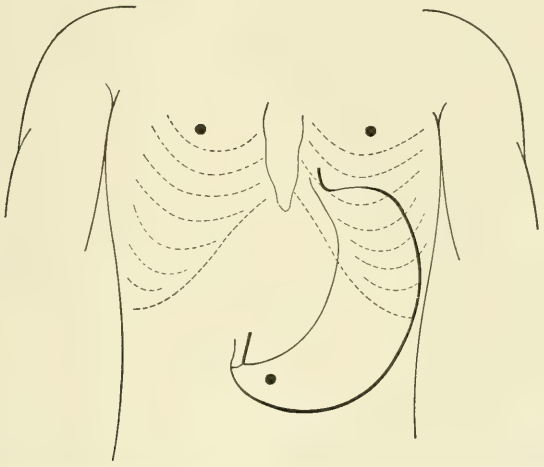
and the umbilicus. The degrees of ptosis differ widely: the greater curvature may reach the umbilicus or a point several inches below. The gastro-duodenal ligament sometimes gives way in an unusual degree, and the pylorus may thereby be carried down to the level of, or below, the umbilicus, without a corresponding prolapse of the fundus, thus giving the stomach a vertical position.

Gastrectasia may accompany prolapse of the stomach, antedating the latter, or it may result from stenosis dependent upon an acute bend in the duodenum or pylorus. Partial occlusion of the colon is brought about by the acute bend at the hepatic flexure, and the transverse por-

tion is usually found empty, and may be distinguished by palpation, according to Glénard, as a ridge lying across the abdomen, which he terms "corde-colique transverse," but Boas believes this to be the pancreas, which may be more easily felt on account of the prolapsed condition of the transverse colon.

The right kidney is almost invariably displaced, and may be either simply palpable, movable, or floating according as it has or has not a

Fig. 8.



Downward displacement of the pylorus and vertical position of the stomach.

mesonephron. The left kidney is occasionally, but much less commonly, displaced. The liver is not usually out of place, though it sometimes is, and may, indeed, be described as floating in rare instances; the spleen, small intestines, and pancreas may also join in that which may be termed a general visceroptosis. There may also be noted the coexistence of catarrhal, ulcerative, malignant, or neurotic affections of the stomach.

Physical Examination.—The affection is usually seen in slender persons with long, narrow chests showing the marks of the corset. In the standing position the upper part of the abdomen sinks in and the lower projects. In the recumbent position there is sometimes a lateral extension of the abdomen, as distinguished by Glénard, and aortic pulsation is usually observed.

Gastric splashing is easily elicited in a lower than normal zone, and the "corde-colique transverse" before mentioned may be felt near the umbilicus, six to ten centimetres on each side of the median line. In most cases inflation of the stomach is unnecessary to distinguish its prolapsed state, although the diagnosis will be more conclusively made by inflation or by the use of a quantity of fluid in the stomach or by means of the gastrodiaphane. The colon may be filled with water or inflated with air, and its boundaries mapped out. The *x*-ray may be employed for the detection of gastroptosis, it being necessary first to fill the stomach with a bismuth mixture in order to obtain a well-defined shadow.

Symptoms.—Among the symptoms chlorosis is prominent. This fact has received reinforcement from the studies of Meinert. There are usually lassitude and lowered nutrition. Subjectively, there is at times a sensation of weight, often strictly localized at some point on the abdomen, occasionally amounting to severe pain. Besides this, intense neuralgia may occur, resembling the pain of hepatic colic. Complaint is made of gastric distress, made worse by eating. The stomach seems unable to empty itself, and the patient is painfully conscious of the presence of food. Regurgitation is rare, although eructation of gas is common. Constipation is the rule, but there are frequent exceptions. We have seen cases in which diarrhœa was a troublesome symptom. In many cases the symptom-complex is that of neurasthenia.

Treatment.—The use of gastric sedatives when the stomach is excited, or of motor stimulants when there is gastric atony, is indicated as a palliative measure. Aside from temporary comfort, diet avails little. The symptoms are best relieved by such hygienic measures as most improve the general health.

Increase of intra-abdominal pressure by the wearing of a properly fitting abdominal bandage, and the relief of downward pressure made by corsets and the conventional waistbands, are of undoubted value, provided that suitable exercise of the abdominal muscles is practised for a definite period each day while the bandage is in place. At best the bandage is a makeshift, and when the abdominal walls are sufficiently strong should be abandoned. Systematic muscular exercise by Swedish gymnastics should be urged. In severe cases resort should be had to surgery. Nephrorrhaphy alone sometimes affords striking relief.

Other Displacements of the Stomach.—Other displacements of the stomach or portions of the organ may occur. The pylorus is often carried too far to the right, to the left, or downward to or below the umbilicus in malignant disease, with dilatation. Tumors adjacent to the stomach may, if large, change its position. In rare instances portions of the stomach are found in the most remote regions. Welch mentions that part of a dilated stomach may engage in a scrotal hernia, and we have observed an instance in which a large portion of the stomach was found in the left pleural cavity—an instance of diaphragmatic hernia. The position of the stomach may be vertical or horizontal, and thus its axis planes may be changed. Very rarely the stomach is found upon the right side of the body with a transposition of the liver to the left.

Deformities of the Stomach.—In some cases so-called "hour-glass" deformity results from contraction of the organ somewhere between the cardiac and pyloric extremities, or, as Ewald mentions, this same shape may be assumed, owing to exaggeration of the antrum pylori; while some stomachs are sausage-shaped. Gastrectasia really constitutes a deformity of the stomach, and in some cases the fundus becomes markedly pouched like an aneurysm; exaggeration of this pouching may lead to the formation of diverticuli or cavities in which food may lie for an indefinite period. These deformities are rare and are chiefly of pathological interest.

ACUTE CATARRHAL GASTRITIS; PHLEGMONOUS GASTRITIS; TOXIC GASTRITIS; INFECTIVE GASTRITIS.

Since William Beaumont in 1833 published his remarkable conclusions based upon the study of his patient, St. Martin, the subject of acute gastritis has found a definite place in pathology. After the lapse of more than half a century our conception of the morbid process has received but slight modification. There is, perhaps, too great a tendency to find the analogue of gastritis in the inflammation of the mucous membranes more readily observed, and by many the process continues to be classed as a catarrh of the stomach. Although under certain conditions the gastric mucosa is capable of secreting mucus abundantly, yet in health the goblet-shaped mucous glands are numerous at the cardia only, and rapidly disappear as the pylorus is approached, so that few are found in the fundus and none at the pyloric extremity of the organ. The gastric mucosa is, in fact, a layer of tubular glands closely placed together, and emptied by ducts that are lined by cylindrical epithelium which is continuous on the surface of the membrane. An inflammation of the gastric mucosa or glandular tunic therefore approaches an adenitis in character rather than catarrh of the ordinary mucous membrane. It is true that under inflammatory conditions the goblet-cells extend more generally in the mucosa, and hence more mucus is secreted; and, besides this, the cylindrical epithelium when changed by inflammation is capable of secreting mucus. From this standpoint, therefore, the process may be regarded as catarrh, and it would seem that the term that most fitly describes an inflammation of this structure is catarrhal gastritis, which may occur either as an acute or a chronic affection. Before taking up the etiology of gastritis it is best to consider certain extrinsic factors that influence first the function of the stomach, and next its morbid processes.

First, the blood supply is subject to variations regardless of the requirements of the organ, as a result of interference with the general and portal circulations, particularly in diseases of the heart, lungs, and liver. Second, there is very close relation between the functional states of the stomach, the intestines, and the liver, and the morbid condition of one of these invariably results in a disturbance of the other two. Congestion, an ever-important factor in inflammation, may thus frequently embarrass the gastric mucosa through these means, when no cause for such congestion exists in the stomach itself. As has been stated when speaking of functional disorders of the stomach, that organ is influenced through nervous reflexes from many remote irritations. It is known that the stomach may be irritated, congested, its secretions excited or diminished, its motion stimulated or held in abeyance, and its sensation disturbed in various ways by the gastric neuroses. It is not easy to draw the line between certain functional disorders and those structural changes that can be called inflammatory. Unquestionably, many so-called instances of acute gastritis are in fact cases of hyperchlorhydria, gastric anacidity, or gastric hyperæsthesia; on the other hand, it is probable that the various gastric neuroses play an important rôle in the evolution of gastritis. Differentiation in the processes is not now under discussion, but it is proper to call attention to the fact that

gastritis, common though it be, does not exist as frequently as has been supposed.

Acute Catarrhal Gastritis.—This affection occurs in various degrees of severity, from a mild inflammatory process unaccompanied by febrile disturbance to an active and deep inflammation of the mucosa accompanied by marked toxæmia, high temperature, and other serious constitutional manifestations.

Etiology.—The causes that produce congestion of the gastric mucous membrane and the various functional disorders that lower the resistance of the stomach invite inflammation. The exciting causes may be found in overtaxing the stomach by the ingestion of an excess of coarse, undigestible food materials or of poorly prepared or irritating foods. The frequent repetition of such indiscretions further and further depresses the resistance of the stomach, and an inflammatory reaction occurs undoubtedly, assisted in many cases by acrid products of fermentation in the stomach contents, either with or without the invasion of the tissues by bacteria. Certain substances, such as shellfish, fungi, and "high" game, are prone to excite gastritis in some individuals, and other substances that are usually wholesome may overtax the stomach sufficiently to induce inflammation under certain circumstances. An excellent illustration of this may be seen in the very young, in whom gastro-enteritis is easily set up by the use of substances wholesome for the more sturdy adult, but positively dangerous to the undeveloped child. Analogous to this is the gastritis that occurs from the indiscreet feeding of the convalescent or the aged. There is truth in the popular belief that taking cold will induce a mild gastritis, just in the same way that an enteritis with profuse diarrhœa is sometimes established. Gastritis is almost invariably associated with the acute infections, and in some of these death takes place as a direct result of this complication. By some writers this form of the disease is described as a special affection under the name of "sympathetic gastritis."

When the general resistance of the patient is reduced by prolonged fatigue comparatively trivial indiscretions in diet will excite gastritis. Such dietetic faults become more harmful when, because of poor teeth or hurried eating, proper mastication is neglected. It is not impossible that dental caries, stomatitis, and disease of the naso-pharyngeal cavities may be occasionally the source of infection in gastritis.

Pathological Anatomy.—The post-mortem observations of the stomach are notoriously unreliable, owing to the rapid disorganization that takes place by reason of the activity of the digestive ferments upon the mucosa. Studies upon animals have confirmed the description given by Beaumont of the process in man. The mucous membrane becomes swollen and hyperæmic. Projections like deep-red pimples are distributed over the surface, some sharp-pointed and red, and others containing serum, changed epithelium, or pus; and in other places irregular red patches, varying in size from a small point to an inch or more in circumference, are to be seen. In connection with these may be aphthous crusts. Abrasions and erosions of the mucous membrane may occur, and shreds of tissue may be dislodged. The interglandular substance is infiltrated with leucocytes and distended by serum. Some of the peptic glands are abnormally granular. At first the gastric

secretion may be increased; later on an excess of mucus appears, and hydrochloric acid is found absent, while in some cases fermentation acids are found in large amounts.

Symptoms.—In the mildest cases the symptoms of catarrhal gastritis are of short duration, and consist of gastric uneasiness, with loss of appetite or disturbance of the sense of taste, generally accompanied by constipation. The tongue becomes coated and the complexion loses its clearness. Twenty-four hours may suffice for the restoration to normal condition. In more aggravated cases there is a sensation of uneasiness, and sometimes there are pain in the stomach and tenderness upon pressure. There are nausea and vomiting, first of the stomach contents, and then of a watery mucus. The tongue loses its tone, becomes broad and indented by the teeth, and is covered with thick white fur; the breath is offensive, and patients complain of a disagreeable taste in the mouth. The bowels are generally constipated, at least in the beginning of the attack; later on there may be diarrhœa as the result of extension of the process into the intestine. The area of hepatic dulness is usually increased one inch or more, and there is sometimes tenderness over the liver. The skin, while not icteric, has a suggestion of that appearance, and is clammy and loaded. The pulse is increased in frequency, small in volume, and usually weak in force. There is a sensation of lassitude, often very marked, accompanied by headache and general malaise. The urine is scant, high colored, very acid, precipitates urates in abundance, and often shows a marked reaction for indican. These symptoms rarely continue longer than two or three days, then gradually subside, leaving a somewhat irritable stomach for some time after. In the most acute cases, and those in which the inflammatory process reaches the deeper portions of the glandular tubules, and in which round-cell infiltration and serous exudation are marked—where, in fact, there occurs a real inflammatory œdema—the constitutional symptoms are correspondingly serious, and it is common to find high temperature, frequent and thready pulse, with persistent and painful vomiting, and the picture of prostration that is seen in all severe abdominal inflammations. Schmidt, Gussman, and others support Lebert in the position that symptomatically there is reason for believing in an infectious gastritis pursuing a course similar to that of typhoid fever. While many of these cases have been reported, it is not shown that they are not instances of the so-called sympathetic gastritis. It must, however, be noted that the disease may persist with temperature and prostration for a week or more, accompanied by marked loss of flesh and general disturbance of nutrition, when no other disease can be detected.

Treatment.—The indications for treatment are to remove the irritating cause and the succeeding toxæmia, and provide the stomach with rest. Where vomiting has been profuse it will not be necessary to empty the stomach, but in other cases an emetic dose of ipecac should be given, succeeded by large draughts of warm water. No food should be allowed, but water may be taken either very hot or with shaved ice. If useless retching persists after the stomach is empty, it may be soothed by chloroform water, menthol water, bismuth subcarbonate, or the cerium oxalate. The last-named drug is probably the most useful. A

mixture of one fourth of a grain of cocaine with a drop of carbolic acid, given in a little mucilage water, is sometimes very effectual. Where ipecac has not been used as an emetic it may be employed frequently in very small doses to relieve nausea. It is always important to procure an early evacuation of the bowels, for which perhaps it is wise to administer a full dose of calomel, ten grains for an adult, and follow it after three or four hours by an appropriate saline draught. After free catharsis the nausea usually subsides. Sometimes purgatives are not retained, and their administration must be postponed. It is not necessary to use anodynes, save in very severe cases where much pain and other serious constitutional symptoms are present; then morphine may be given hypodermically in small doses, to be repeated guardedly. The unnecessary use of opium in this affection is objectionable on the ground that it opposes elimination, and in gastritis there is always sufficient disturbance of the entire alimentary tract to create toxæmia, which is responsible for many of the general symptoms. Finally, local applications may be of service; poultices or hot fomentations over the epigastrium are very grateful to the patient, and sometimes more relief follows from a full hot bath than any other measure. The most sensible treatment is a mercurial purge, diaphoresis by the hot bath, complete rest in bed, and absolute abstinence from food until the attack has passed by.

Phlegmonous Gastritis.—Phlegmonous gastritis is a very rare affection, and is sometimes found to accompany acute infectious processes, at other times apparently occurring as an idiopathic affection. In 1892, Mintz had been able to find but 43 reported cases. Its exact etiology is not known, although it has been met with more commonly in men than in women. It occurs as a diffuse purulent infiltration of the submucosa and muscular layer, usually appearing as scattered abscesses, but occasionally localized as one or two large abscesses which may be felt upon palpation. These may rupture internally into the stomach or may discharge themselves into the peritoneal cavity.

Symptoms.—The most striking local symptom is pain of great severity, burning in character, in the epigastric region, accompanied by marked tenderness, and sometimes by a sensation of fulness or distention. There is occasionally constipation, but more often diarrhœa with tympanites. There is absence of tenderness upon pressure over the lower portion of the abdomen, and movements of the patient are believed not to cause the severe pain found in peritonitis. There is incessant, painful vomiting, the tongue is heavily coated, and the breath offensive. The temperature reaches 104° or 105° F., the pulse is exceedingly rapid and feeble, and chills or chilly sensations occur. The diagnosis is rarely made, for the reason that the constitutional symptoms may as well belong to any other abscess as to phlegmonous gastritis. The disease resembles circumscribed peritonitis. It commonly terminates in death, although recoveries have been reported.

Toxic Gastritis.—This term is limited to inflammation of the stomach produced by the swallowing of caustic or intensely irritating substances, as, for instance, the mineral acids, caustic alkalies, arsenic, phosphorus, mercuric chloride, and alcohol.

Pathological Anatomy.—When the poison is sufficiently caustic there will be found destructive lesions of the mucous membrane of the

mouth and pharynx. The appearance of the gastric mucosa varies according to the character of the poison, the amount taken, the quantity of stomach contents present when the poison is swallowed, and the length of time elapsing before its removal. When the irritative substance is diluted or when there is present a large amount of food material in the stomach, the damage to the mucous membrane may be slight, involving only the superficial epithelium and not extending into the glandular tubules. The epithelium shows cloudy swelling and fatty or mucoid degeneration. A marked hyperæmia exists, and erosions of the mucous membrane may be found at scattered points where the surface was most exposed. More marked changes follow the introduction of the stronger mineral acids, and vary in appearance according to the variety of the acid. For instance, from strong hydrochloric acid there results a white, bleached-out appearance; from sulphuric acid the tissues have a yellowish hue; and from arsenic acid a thick croupous exudate sometimes covers the mucous membrane. In fact, the appearance of the lining of the stomach varies strikingly according to the nature of the caustic substance taken. The inflammation extending into the tubules results in necrosis of the glandular structure and a round-cell and serous infiltration of the submucosa or even deeper parts. At other times large patches of the mucous membrane slough off, and when repair occurs, it shows an increase in stroma and a decrease in glandular elements. In severe poisoning the mucosa is largely destroyed, and, if life is sufficiently prolonged, becomes a dark-colored bleeding slough, accompanied by erosion and ulceration. Ebstein has shown that in cases of poisoning by alcohol and phosphorus the gross appearance of the stomach may not show much alteration from the normal, but microscopic examination reveals cloudy swelling and fine granular degeneration involving the mucosa and submucosa, accompanied by slow destruction of the glandular elements and the progressive increase of connective tissue. Should improvement occur after toxic gastritis, the convalescence is slow, and the secreting function of the gland is likely to remain embarrassed because of the cicatricial changes in the mucosa; deformity of the organ may result from deep ulceration and resulting scars.

Symptoms.—The patient experiences intense pain in the region of the stomach, made worse by the accompanying vomiting. The vomited matter shows bloody mucus or blood and shreds of mucous membrane, and later the presence of pus. The constitutional symptoms are great prostration, partly the result of shock and partly of toxæmia; there is rapid, feeble pulse, coldness of the extremities, a high temperature, and generally scant and sometimes albuminous urine; the bowels are usually constipated. In mild cases the symptoms are of course less conspicuous.

Diagnosis and Treatment.—There is usually history of the poisoning to assist in forming a diagnosis. When the mineral acids, ammonia, and some other substances are swallowed, the nature of the trouble can be approximately learned by the appearance of the mouth and throat. When possible it is important to ascertain the exact nature of the poison, as the treatment is considerably modified thereby, but when the history and the appearance of the fauces fail to provide the necessary information it is wiser not to begin special treatment until

the stomach has been emptied and the nature of the poisonous substance ascertained. The first steps toward relief are the dilution of the stomach contents by large draughts of water, to be immediately followed by the emptying of the stomach by an emetic or the stomach tube. Unless there is serious destruction of the mucous membrane of the pharynx, it is wiser to practise lavage, continuing it until the stomach is completely emptied. If a stomach tube is not at hand, a hypodermic injection of apomorphine should be given, and in the mean time steps taken to wash out the stomach. In the absence of the ordinary instrument a piece of common rubber tubing may be employed. If acids have been taken, large amounts of the light magnesium carbonate and a solution of sodium bicarbonate should be immediately swallowed. When the poison consists of one of the caustic alkalies, lemon juice, tartaric acid, and the common cream of tartar or vinegar should be administered, well diluted. The success attending the local treatment of the stomach will depend upon the promptness with which it is carried out. Quickness in utilizing the first convenient remedy will often save life, whereas the time lost in searching for ideal measures may lead to a disastrous termination. One attendant should rapidly administer raw eggs, mucilage, or flour paste, while a second is taking steps to empty the stomach. Subsequently the bowels should be thoroughly moved by large doses of magnesium sulphate. Castor oil may be selected for the same purpose, except in phosphorus-poisoning, when all fats must be avoided. A solution of the cupric sulphate may be administered after phosphorus, and the freshly prepared hydrate of iron, or dialyzed iron to which salt has been added, after arsenic-poisoning. Where an opportunity for further treatment of the gastritis occurs the patient should be supported by rectal alimentation and the stomach kept at rest. Mucilage water with the bismuth salts is at times admissible. It will be found necessary to use morphine subcutaneously to relieve shock and depression.

Infective Gastritis.—Inflammation of the gastric mucosa is seen as a complication of many acute infective diseases, and is sometimes described as sympathetic gastritis. Considerable attention has been given to the study of local infection as a cause of gastritis. In certain cases no other cause is found, but more often there is preceding hyperæmia or chronic gastric catarrh not connected with infection. So far, the matter possesses more pathological than clinical interest, but the field promises to reward further investigation. At present we are not prepared to state that there exists any special form of inflammatory stomach disease dependent upon ascertained bacterial invasion, although instances are not wanting of infection from streptococci, organisms of the proteus group, and the colon bacillus. Fränkel, Deininger, and Klebs have described peculiar conditions of the stomach depending upon organisms not strictly classified. So far as known, the treatment is the same as that described for acute gastritis of the common type.

CHRONIC GASTRITIS; EROSIONS OF THE STOMACH.

Definition.—A secondary chronic inflammation of the stomach involving the mucous membrane and underlying tissues, sometimes chiefly affecting the mucous membrane, at other times the submucosa and muscular layer.

Etiology.—Persistent functional disorders of the stomach are apt to cause catarrhal gastritis, owing to impairment of epithelial and glandular vitality, imperfect digestion because of excess or diminution of secretion, or delay in the propulsion of food onward from atony. It may result from repeated attacks of acute or subacute catarrhal gastritis, especially in cases when these are caused by over-indulgence in irritating and indigestible foods or alcohol. The habit of hurried eating, with insufficient mastication and consequent poor insalivation, not infrequently gives rise to catarrhal gastritis, especially when large, coarse masses of food are swallowed. Highly irritating condiments, such as mustard, pepper, and spices, too freely used, may in time induce a chronic inflammation which may be superimposed upon prolonged congestion of the mucous membrane. The disease occurs secondarily to some organic disease of the stomach, especially carcinoma and gastrectasia; it may also accompany gastric ulcer. Passive hyperæmia of the stomach consequent upon the obstruction to the portal circulation from hepatic cirrhosis, pulmonary emphysema, chronic bronchitis, non-compensated valvular heart disease, or disease of the myocardium, renders the mucous membrane vulnerable to the invasion of bacteria or the irritation of fermentation resulting from their presence. The affection also occurs in the course of chronic diseases, such as tuberculosis, gout, diabetes mellitus, and nephritis, partly depending upon toxæmia and partly upon reduced resisting power. Caries of the teeth or gingivitis, with an unhealthy condition of the mouth and nose or post-nasal cavity—as, for instance, ozæna—may cause catarrhal gastritis, owing to numerous putrefactive micro-organisms and their products that may be swallowed. Excessive use of chewing tobacco or alcohol is liable to induce the disease, and as an illustration we have observed the case of a man who made a practice of holding an unlighted cigar between his teeth most of the time, gradually chewing it to a stub, and from whose stomach we have upon several occasions washed a considerable quantity of tobacco with an abundance of ropy mucus. The patient complained of gastric discomfort and anorexia, and was relieved by discontinuing the habit. The stomach almost constantly contains a variety of bacteria, and it is very probable that catarrhal gastritis is sometimes caused by their action.

Pathological Anatomy.—At autopsy the mucous membrane appears somewhat thickened, although it may be thin in areas; it is covered with a layer of mucus which may be clear and thin or tough, grayish, and thick; it has a yellowish gray color with areas of deep red injection, especially near the pylorus; there may be small spots of extravasation presenting a dark purplish red appearance; the thickening of the mucosa may cause numerous slight elevations, papillary in character, especially near the pylorus—"état mamelonné" of the French. In some cases the submucosa and muscularis are considerably thickened,

and, as the process is usually most marked at and near the pylorus, this thickening may cause more or less occlusion of the pyloric orifice; this condition really constitutes an interstitial gastritis. The nethermost part of the large curvature is sometimes softened, pliable, and gelatinous, the wall being thin, perhaps consisting only of the serous coat; this may be a post-mortem change, but, at all events, the process in this region contrasts strongly with the thickening near the pylorus.

Microscopic examination shows the glandular cells granular and deformed, while the ducts are irregular, constricted, and tortuous; some of the glands are separated from their ducts by the encroachment of newly formed connective tissue, and they appear as cysts partly or wholly filled with epithelial remains. A plentiful round-cell infiltration is seen between the glands, and also a connective-tissue increase reaching from the submucosa upward around the glands. Sometimes the glandular cells are in a state of mucoid degeneration, chiefly in the pyloric region; some cells are granular, while others are partly granular and partly mucoid; these latter may rupture and discharge their contents into the duct of the gland. Hayem distinguishes two varieties of connective-tissue gastritis—mixed and interstitial. Two forms of mixed gastritis are described, one in which the delomorphous (parietal) and the other in which the adelomorphous (central) cells are affected. The former is accompanied by mucous transformation, and the latter ends in atrophy of the gland.

Interstitial gastritis may be subacute or chronic. In the subacute form a marked infiltration of leucocytes occupies the whole mucous membrane and penetrates the gland tubes, some of which become cystic. In the pure interstitial or chronic form there is progressive proliferation of the connective tissue, resulting in secondary atrophy of the glands and ducts, as well as the disappearance of the muscular fibres.

Symptoms.—The symptoms of chronic catarrhal gastritis are so often confused with the symptoms of the diseases that cause it that in many cases it is difficult to draw a definite clinical picture of the affection. The gastric mucous membrane has so much resisting power that it practically ignores insult after insult offered it by dietetic errors, alcohol, or other irritations. A few years ago almost every symptom-complex of the stomach was at once set down as due to subacute or chronic catarrhal gastritis, and even to-day the profession has not cut loose from this short-sighted, erroneous, and superficial habit. In point of fact, chronic inflammatory affections of the stomach are not very common except as a result of grave organic disease located in the stomach or elsewhere. In many chronic diseases—as, for instance, the anæmias—the stomach is the organ that bears the brunt of the complaint of all the cells of the body, and it is not surprising that it should be chosen to cry out and rebel in the cause of the complaining cells depending upon it; but the point we wish to make is that gastritis exists but in a small proportion of these cases, and if the stomach and its contents are carefully studied there will be less often a hasty diagnosis of one or another form of gastritis.

Given a case of gastritis in which secretion and motion are both impaired, and the symptoms usually indicate difficult digestion and toxæmia. Anorexia is commonly, but not uniformly, present; indeed,

in some cases hyperorexia exists and leads to frequent eating, with an aggravation of the symptoms. Usually after meals there is a sense of weight, fulness, and distress in the epigastrium, perhaps amounting to actual pain; eructations are common and afford relief by lessening gastric distention; sometimes, however, the feeling of fulness deceives the patient into believing that gas is present when it is absent, and it is common to hear the expression: "If I could only get the gas off my stomach, I would be relieved." Burning sensations, accompanied by considerable nervous perturbation, are often noticed, but severe pain is uncommon. Tenderness upon pressure over a considerable epigastric area, and a sense of soreness upon forcible inspiration or contraction of the abdominal walls, are not infrequently present. Nausea sometimes occurs after meals, and may be accompanied by vomiting, or these symptoms may manifest themselves early in the morning or after breakfast only, the later meals in the day being taken with comparative comfort. Morning vomiting is commonly associated with alcoholic gastritis, and, indeed, may be as much a manifestation of toxæmia, renal or otherwise, as of the local gastric state. Light meals of plain food are not usually followed by the same degree of discomfort that is consequent upon heavy mixed meals; this the patient discovers. The tongue may be coated with a yellowish-brown or yellowish-white thick fur, or it may be clean, red, or glazed with denuded epithelium; it is not characteristic, as is so frequently stated. It may be pale, broad, flabby, and indented from anæmia and poor nutrition; not infrequently two lines of froth are seen lying from a quarter to half an inch from the edge, one on each side, commonly indicating a nervous state. Unhealthy buccal conditions may cause an offensive breath. The taste is bitter and unpleasant in the morning, at which time the coating on the tongue is usually most abundant. Constipation is present as a rule, or it may alternate with attacks of mild diarrhœa, and intestinal flatulence is often present. Thirst is not as common a symptom as some have supposed; indeed, in few of our cases has it been noticeable. Headache is not uncommonly present, usually being dull and heavy in character and accompanied by an unpleasant hebetude and indisposition toward mental or physical exertion. Vertigo is sometimes complained of, especially after eating or during a meal; it is usually accompanied by a distressing fulness in the head, and perhaps slight nausea. The urine is apt to be superacid, high colored, of high specific gravity, and upon standing deposits an abundance of urates, with, perhaps, uric-acid and calcium-oxalate crystals; but many exceptions are seen, and phosphaturia may occur, or a large quantity of pale urine of low specific gravity; a trace of albumin may be found and indicanuria occurs in a considerable proportion of cases. The general nutrition suffers, and, as a rule, anæmia and a muddy, sallow, loaded skin, with loss of weight and strength, are seen. The blood presents the picture of secondary chlorosis in most instances, although a pernicious type of anæmia may result if the morbid process goes on to complete glandular atrophy of the stomach. Flint, Osler, and others have described such cases, and consider this condition as one of the causes of pernicious anæmia. We have observed a number of cases with gastric glandular atrophy whose blood was simply chlorotic, but we have not yet seen

pernicious anæmia associated with this gastric state, probably because intestinal digestion was amply sufficient to compensate for the lack of stomach digestion in our cases.

Diagnosis.—The diagnosis cannot be made from the symptoms alone, as they may accompany divers conditions of the stomach; they are, however, of some importance in connection with the cause of the affection and the examination of the stomach contents, which should be withdrawn an hour after the Ewald test breakfast of a roll and water. Usually considerable gastric mucus is found holding food particles in its meshes; free hydrochloric acid is diminished or absent; lactic acid may be present, sometimes in sufficient quantities to give a distinct canary color with Uffelmann's reagent, or it may be absent; in the absence of food-stasis other organic acids are rarely present; the proteoses and peptone are found; starch digestion may or may not be interrupted; the total acidity is not usually above normal unless gastrectasia exists or fermentation occurs; rennet ferment and rennet zymogen are both diminished, as has been shown by Boas and Freidenwald, the former being frequently absent, while the latter may be reduced as low as one third dilution; microscopically numerous micro-organisms, including lactic acid-forming bacilli, may be found. When atrophy of the gastric glands has occurred the total acidity is very low, being from 2. to 5.; free and combined hydrochloric acid is absent, and the biuret reaction is not obtained, as no digestion has taken place. The wash-water in cases of mucous gastritis, which is characterized by excessive quantities of mucus both with and without food, frequently contains fragments of the epithelial covering of the mucosa.

Prognosis.—The prognosis depends partly upon the cause of the disease and partly upon the management of the case. If it is associated with, and secondary to, benign pyloric stenosis and a successful pyloroplasty is done the catarrhal gastritis may be checked, leaving behind it perhaps some atrophy and new connective tissue formation: If it is due to abuse of alcohol, or dietetic errors, the correction of these may result in checking the process entirely, although, as is the consequence of chronic inflammation elsewhere, the organ will be more or less permanently disabled. If the condition depends upon irremediable cardiac, pulmonary, or hepatic disease its progress may be very slow but the prognosis is necessarily unfavorable. If the disease has progressed so far that atrophy of the glands has occurred the nutrition of the patient will depend upon the motor power of the stomach and intestinal digestion.

Treatment.—Appropriate local treatment of the stomach is almost always valuable in this disease. Lavage, not too frequently practised, at once removes irritating and perhaps fermenting food remnants, and if an alkaline antiseptic solution be used, mucus, epithelial débris, and micro-organisms are washed from the surface of the mucous membrane, and peristalsis and secretion are improved. Water at a temperature of 105° F. should be used for lavage, and after the first part of the treatment a 2 per cent. solution of sodium chloride should be employed, as the chlorides are desirable when the hydrochloric-acid secretion is diminished, or a weak solution of Carlsbad salts may be used; and boric-acid solution is one of the best at our command.

Lavage should be given in the morning before breakfast, in order to

discover whether food remains in the stomach over night, thus giving evidence of stagnation. Besides, in this way the patient is not deprived of nutriment, as he will necessarily be, to some extent, when lavage is practised too soon after meals. It is, however, advantageous to wash out the stomach occasionally from three to five hours after a meal, in order to examine the contents and give the organ rest. For the latter purpose the stomach may be emptied about ten o'clock at night, and no food allowed until morning. The importance of sufficient nourishment should be emphasized, as patients frequently weaken themselves in following senseless dietetic rules. Local application to the mucous membrane may be made by means of the stomach tube, the spray apparatus, or the insufflator, or galvanic electricity may be applied by the direct method. Silver nitrate is one of the most effective applications, and may be used in the strength of one to four grains (0.06 to 0.24) to eight ounces of distilled water, which amount is poured into the stomach after it has been washed clean, left there for a few moments, and then withdrawn; if most of it returns, it is unnecessary to use further washings, as a small quantity left in the stomach will be beneficial. The drug may be given in one fourth or one half grain doses in a half ounce of distilled water before meals. Its administration, however, should not be too long continued without an intermission of several days. Fluid extract of hydrastis may be used as an astringent after lavage, one or two drachms (4. to 8. c.c.) in four or eight ounces of water being employed, or it may be given in half to one drachm doses before meals. Oil of cinnamon, oil of cloves, oil of eucalyptus, or menthol may be used in a vaporized oily fluid, cosmoline or albolene being employed as a menstruum. Pick uses a narrow tube which is inserted through an ordinary stomach tube at the conclusion of lavage, and with 250 cubic centimetres of air inflating the stomach to prevent closure of the end of the tube, bismuth subnitrate, dermatol, or other powders are introduced by insufflation. We frequently use positive galvanic electricity within the stomach, agreeing with Einhorn that it stimulates secretion and in an electrolytic manner favorably affects the chronic inflammatory process.

The diet should consist of an abundance of thoroughly cooked starchy foods, such as stale bread (light and sweet), rolls, zwieback, Graham wafers, saltines, water crackers, ginger wafers, toast, and mealy baked potatoes in moderation; puddings should not be allowed, as they are not masticated and readily ferment. The amount of albuminoid food should be somewhat restricted if free hydrochloric acid is absent, and that which is allowed should be in the most digestible forms. Hard-boiled eggs and tough fibrous meat, too fat meat, shellfish like lobsters, oysters, and crabs, sausages and smoked meats, should not be allowed; cheese, salads, vinegar, condiments, and concentrated alcoholic drinks should be interdicted; and of the vegetables cabbage, cauliflower, cucumbers, beans, and peas should be excluded.

A suitable dietary includes small quantities of clear soups, bouillon, and clam-juice; tender fresh fish, such as bluefish, whitefish, shad, perch, trout, or bass; choice meats not overcooked—for instance, porter-house steak that has hung long enough, roast beef, tender lamb chops, tongue, very thin slices of cold-boiled ham, sweet-

breads; fresh raw eggs, soft boiled, poached, or delicate, light omelettes; farinaceous foods, stale bread, toast, Graham bread, zwieback, rolls, crackers, spaghetti, arrow-root, etc.; lettuce, water-cresses, celery, baked potatoes. Milk agrees in some cases, but is often found in large curds in the stomach; it may, however, be taken if it is liberally diluted with lime-water, Vichy, or seltzer, or if it is peptonized. Carbonated waters, tea and coffee in moderation, cocoa, koumyss, matzoon, claret, and Rhine wines may serve as beverages, although, as Sir William Roberts and Chittenden and Mendel have shown, wines greatly retard salivary digestion. Patients should have good teeth, artificial if need be, and should masticate slowly and thoroughly. Among the few drugs that are useful in this affection hydrochloric acid stands first. It partly supplies the deficiency of the secretion, retards fermentation, combines with the nitrogenous elements to form syntonin, and probably has some salutary effect upon gastric motility. The doses ordinarily employed are not large enough, as it should be given in twenty or thirty drops of the dilute acid in plenty of water after meals, the dose being repeated in an hour. As large doses are strongly acid, they should be taken through a glass tube to protect the teeth and render it less unpleasant. The administration of pepsin is not usually necessary unless glandular atrophy exists, under which circumstances it may be used; ordinarily, however, the wholesale employment of pepsin is unscientific and needless.

Of the bitters and stomachics employed in this disease, nux vomica is the most valuable; the tincture, extract, or powder may be prescribed Tr. nucis vomicæ should be given before meals in from twenty to thirty drop doses, or strychnine in doses of one thirtieth to one twenty fifth of a grain may be used in its stead.

Quassia and condurango are sometimes beneficial, the infusion of the former and decoction of the latter being the favorite preparations. Calumba, cinchona, gentian, chamomile, and chirata may be useful in some cases. Constipation is best controlled by the saline cathartics; Carlsbad, Hathorn, Hunyadi, Friedrichshall, Rubinat-Condal, or other waters may be chosen according to the predilection of the patient or the physician. Some salines are preferably used hot an hour or so before breakfast, in that way loosening adherent mucus from the walls of the stomach and carrying it onward before food is taken. Given in this way they also serve as diuretics, and the concentrated condition of the urine before mentioned is often thus corrected. It may be advisable at times to give moderate doses of calomel or the vegetable laxatives, such as aloin, podophyllin, cascara, or some purgative containing senna. Colon flushing may be practised occasionally with a happy effect in many cases, and, if constipation is obstinate, Fleiner's method of injecting from a half to one pint of warm, pure, olive oil into the colon may be resorted to. Tonic hydrotherapy, medical gymnastics, hot air or Turkish baths, out-of-door exercise, plenty of sunlight, sea-bathing, mountain-climbing, freedom from worry and care, all exert a happy effect and may be heartily recommended.

Erosions of the Stomach.—Erosions of the gastric mucosa were long ago recognized and have been described by many pathologists. As the term implies, the defect does not penetrate deeply, but, as a rule,

attacks the superficial epithelium only, sometimes involving portions of the submucosa. Frequently the process is implicated with slight hemorrhagic infiltration, which, according to Virchow and others, may be accounted for by spasmodic contraction of the muscular layer, thus effecting a disturbance or an arrest of the circulation in the folds of the mucous membrane, causing localized congestion and extravasation. As has been said, hemorrhagic erosion is believed by some observers to play an important etiologic rôle in peptic ulcer. As Langerhaus has pointed out, the seat of hemorrhagic erosion is as frequently found in the fundus as in the pyloric end of the stomach; it is located upon the surface of the rugæ of the mucous membrane, is generally multiple, and is often irregular in shape.

Etiology.—The cause of gastric erosions is not altogether understood. It is generally believed to depend upon local spasms of the muscularis resulting in small extravasations of blood, also upon the presence of catarrhal gastritis. It is common to find both deep and superficial erosions in toxic gastritis. Superficial erosions frequently accompany other forms of gastritis. Since Einhorn in 1894 made his report upon clinical observations on erosions of the stomach, more attention has been given the subject, and there is ground for the belief that it may exist as a very chronic affection, the cause of which is unknown.

Pathological Anatomy.—The erosions are usually multiple, sometimes accompanied by slight hemorrhages, appearing scattered over the surface of the stomach as numerous dots or streaks. Small pieces of the mucous membrane are frequently shed, and may be vomited or removed by lavage, and upon examination show the well-defined glandular structure of the gastric mucosa.

Symptoms.—The patient usually complains of epigastric tenderness and moderate distress after eating. The appetite is variable and is sometimes absent. Vomiting is rather rare, but sometimes occurs, when particles of mucous membrane may be discharged. Constipation occurs, and there is usually considerable mental depression. The stomach contents sometimes show the presence of free hydrochloric acid, though it is usually diminished in quantity and may be absent. As a rule, the organic acids are not found. The most striking symptom of the affection is the frequent appearance of small portions of the gastric mucosa, together with a moderate amount of mucus appearing in the water after lavage.

Prognosis and Treatment.—The disease sometimes continues as a chronic affection, and is very intractable to treatment. Recovery often takes place, and, so far as known, no fatal termination is recorded. Einhorn recommends spraying the gastric mucous membrane with 1 : 1000 silver nitrate solution or 1 : 100 solution of aluminol or a solution of ichthyol. We have used these measures, together with lavements of solutions of boric and tannic acids and potassium permanganate, sometimes with apparent benefit; in one case after six months' treatment we saw not the slightest improvement. Attention to the general health is important, and to that end strychnine, arsenic, malt, and cod-liver oil, fresh air, sunlight, mountain-climbing, and other invigorating exercise, may be recommended.

DISEASES OF THE INTESTINES.

By WILLIAM W. JOHNSTON, M. D.

ULCER OF THE DUODENUM.

Synonym.—Peptic ulcer of the duodenum.

Definition.—A circumscribed superficial loss of substance of one or more coats of the duodenum, beginning in the mucosa, and due to a localized, molecular necrosis without any active process.

History.—The disease was first described by Robert in 1828, but it was regarded as merely a pathological curiosity until Collins collected 262 cases in his thesis. It has received but scant attention from authors of textbooks, pathologists, or essayists. Practically, all that is known of it that is of scientific value is the result of investigations in the past two decades.

Etiology.—The etiology of ulcer of the duodenum is often considered identical with that of gastric ulcer, but a separate description is necessary on account of certain peculiar causes and its distinctive clinical history.

Of course there is much diversity of opinion in the statements of essayists as to the absolute frequency of this affection. Thus Perry, in 17,652 autopsies at Guy's Hospital upon patients dying from all causes, found the lesion only 70 times (0.4 per cent.), while Letulle, in 52 cadavers taken at random, found it 4 times (7.8 per cent.). As Oppenheimer suggests, it is frequently overlooked, and evidences are not wanting that some cases in which the disease has been definitely diagnosticated at a period some years before death present no post-mortem evidences of it. As compared with gastric ulcer, its frequency is one to thirty; but Trier places it as one to nine. Gastric and duodenal ulcers coexisted in 31 of 358 cases reported by Oppenheimer and Lebert.

Predisposing causes seem to play but a small part in the etiology of this disease. Thus chlorosis, anæmia, and cachectic states, which act so definitely in causing gastric ulcer, have no such action here. But debility from any cause will greatly protract the disease once it has been established. Unlike the gastric ulcer, again, duodenal ulcer is from two to three times more frequent in men than in women. In 234 cases collated by Collins, 63 were females.

It is most common in the third, fourth, and fifth decades, decreasing progressively in frequency in the order named, but it has been found at all ages, from one day to one hundred years. One fact of peculiar interest and importance is its frequency in infancy and early childhood. Thus 82 of 692 cases reported occurred before the tenth year. It is a

much-discussed question whether these early lesions originate in intrauterine life from defective nutrition and destructive lesions in the vessels, or result from the traumatism of labor. Klebs considers them due to follicular hemorrhage, and, as they undoubtedly occur oftenest in children born after long and difficult labors, this theory has much plausibility. Instrumental deliveries, deliveries by the breech, and other conditions might easily cause hemorrhages into the mucosa and submucosa which would quickly lead to local necrosis.

A great number of the primary and secondary causes of the disease are known. Most obvious among these are extensive burns of the skin, whose agency is well illustrated by Holmes' statistics. The ulcer was found in 16 of 124 patients dead from such burns. The rule as to greater frequency in men is reversed in the case of burns, the lesion due to this cause occurring twice as often in women as in men. How burns cause this distant complication is still unsettled, but they probably do so by the liberation of a fibrin ferment with consequent thrombosis of the duodenal vessels, or by the formation of some toxic material in the blood or affected tissues, which toxin is excreted in the bile. In this connection it is important to note that Kyanitzki has separated from the blood of animals, suffering from extensive burns, a toxin which, when injected into other animals, will cause (among other phenomena) duodenal ulcers.

In most of the unclassified cases the greatest support is given to Virchow's theory that the loss of intestinal substance is caused by the action of the gastric juice upon some spot that has been deprived of its nutrition by spastic contraction of the muscular coat, or by embolism, thromboses, atheroma, or other condition of the afferent vessels which would produce localized anæmia. That embolism would seem to play a small part in this process is inferred by remembering that in ulcer of the stomach or duodenum it is rarely seen simultaneously in other parts, that there appears to be no ulterior cause for the formation of emboli, and that in those conditions in which embolism might be anticipated—*e. g.* vegetative endocarditis—ulcers of the alimentary tract at any point are rarely found. Experimentally, however, embolism has been proved to be a cause by Cohnheim and others, who produced typical lesions by introducing multiple emboli into the gastric arteries. The excessive acidity of the gastric juice that is said to correlate this localized anæmia is denied by Ewald, Ritter, Hirsch, and others, who cite cases in their support.

In this age of bacteriology testimony is not wanting to show that cases may be due to microbic infection. Letulle has thus caused it several times experimentally, and it is certain that the disease is sometimes seen as a complication of some infectious diseases, especially septicæmia and dysentery. Finally, pemphigus, erysipelas, and trichinosis have been mentioned as causes.

Pathological Anatomy.—The mucous membrane shows no evidence of any pathological change up to the immediate edge of the ulcer. The lesions themselves are, in almost all respects, similar to those found in the stomach. The vast majority of them are in the upper horizontal third of the duodenum, progressively diminishing in frequency from above downward to the papilla bilaria, which is the point of the lowest

extension. When multiple they are invariably confined to the upper third. Usually they are found on the anterior wall. Thus of 127 cases examined 71 were on the anterior, 45 on the posterior, 10 on the superior, and only 1 on the inferior, wall. In about 60 per cent. of the cases the lesion is single. If several coexist they are usually in different stages of development, from the earliest stage of formation to cicatrization.

The ulcer is round, or more rarely oval or elliptical, in which latter case the long diameter invariably corresponds with the long diameter of the bowel. An average diameter is about 2 cm.; it is rare to see this less than 1 cm. or more than 3.5 cm., but Axelkey has reported a case in which the measurements were 7 cm. × 1 cm.; and, as suggested below, it may be so small that though there were definite symptoms of duodenal ulcer at a period some time prior to death, there may be no post-mortem evidences of its existence or cicatrization. The depth, of course, varies with the extent of penetration, but usually the floor is formed by the muscular coat. If the ulcer penetrates to the peritoneum, local adhesions usually form, but in many cases—perhaps in a larger proportion in this than in any other disease—they do not, and perforation results. Even when adhesions have formed the ulcerative process may continue, and fistulæ have been found connecting the duodenum with the gall-bladder or transverse colon.

The terraced, crater-like shape is very characteristic, and when the ulcers are recent the edges are sharp-cut and smooth. In older cases they are thickened and indurated, and occasionally there is much contraction and puckering of the entire intestinal wall. Eventually this may lead to stenosis. In very rare cases cancerous infiltration has occurred in the floor of the ulcers. In those cases in which jaundice has existed there has usually been an extension of the necrotic process to the walls of the common duct.

The mucosa is, of all coats, that most affected. Pus and granulation tissue are absent; if these are produced, they disappear by digestion. Almost all the glands of Lieberkühn are lost, but on the edges they appear as dilated cubical cul de sacs filled with a clear thin fluid and desquamated epithelium. Later they are occluded at their orifices and become veritable cysts. The acini of the glands of Brunner are dilated four or five times larger than normal, and are filled with a colorless mucoid mass, the retained product of their secretions. The epithelial cells of the acini are flattened, the nuclei shrunken, and the cell protoplasm is granular. The interstitial matrix is infiltrated with small embryonic elements, and is the site of small hemorrhagic foci which extend into the adjacent submucosa. This latter coat is generally intact quite up to a very short distance from the edge of the ulcer. It there takes on a more or less inflammatory character, contrasting strongly with the necrosed tissue that forms the immediate border of the ulcer. If the muscular coat is involved, the fibres lose their distinctness and are pushed apart by interstitial infiltration of embryonic cells and vascular proliferation. The floor of the ulcer is invariably smooth, whatever its depth or the coats that it penetrates. In short, the appearance is that of an atonic ulcer, incapable of an exuberant reparative vitality, showing a molecular necrosis more or less slow, and exempt through this

same cause from great suppurative or gangrenous destruction. In those rare cases in which progressive pernicious anæmia seems to arise in the course of the disease, the blood examination shows intense oligocythæmia, the red corpuscles for the most part are small, and some re-formed macrocytes are seen.

Symptoms.—Duodenal ulcers may be divided into—(1) Ulcers giving no evidence of their presence during life, but found post-mortem; (2) Ulcers which cause no symptoms until perforation or sudden fatal hemorrhage occurs; (3) Ulcers recognizable by characteristic symptoms. These may, after a chronic course, end fatally by hemorrhage or perforation, or they may be cured by treatment or without it.

(1) From the statistics of post-mortem rooms, as opposed to the comparative rarity of the disease in general practice, it is probable that a large number of cases fall in the first category. But as they have no clinical value they need not be discussed here.

(2) In the second class there are no doubt many cases that are wrongly diagnosticated, the principal symptom—pain—being assigned to gastralgia, neuralgia, or gastric ulcer. Of 150 cases collected by Perry, 91 presented no symptoms until twenty-four hours before death, which occurred either from hemorrhage or, more frequently, from perforation. After either of these accidents the symptoms are the same as when they occur under other conditions, except that death does not ensue so quickly because there has been no prior exhaustion. In this connection it is important to note that often there are in reality minor symptoms which may not attract attention. But since in this class, again, a diagnosis can rarely be made with such precision that appropriate treatment may be used, it is to the third class that most attention should be given.

(3) Emaciation is one of the earliest symptoms of the typical chronic ulcer, and a most important one. In many cases it progresses more rapidly than it does in any other disease. Vomiting, though not a constant symptom, is usually present and is chronic, coming on three or four hours after meals. Sometimes it occurs only once or twice in the course of the disease, and, more rarely, not at all. Usually it is due to reflex peristalsis, which, when the ulcer is near the pylorus, may affect the stomach only. The vomitus consists of partially digested food, bile, and occasionally blood. Mayer states that in most cases it has a coffee-ground color similar to that seen in carcinoma ventriculi, but of a peculiar character that is pathognomonic. An examination of Ewald's test breakfast in five different cases showed an absence of free HCl, but an organic hyperacidity from the presence of large amounts of lactic, and sometimes butyric, acid. This condition of the gastric juice Robin considers pathognomonic, but, as only five cases were examined, though found in all, it is too early to draw such a broad conclusion. Dyspeptic disturbances referred to the stomach are rare.

The bowels are but little influenced by the disease. Constipation occurs in a scant majority of the cases, or constipation alternates with diarrhœa. Bright has described the stools of this affection as oily, composed of fat-like masses, or masses from which an oily substance quickly separates itself and floats upon the surface. They are unlike those seen

in pancreatic or hepatic disease. Later writers have failed to find them. Other appearances in the stools are described below.

Icterus is comparatively rare, but it is more frequent than in gastric ulcer; it is usually chronic, with subacute exacerbations.

Pain, the most constant symptom, comes on about one hour and a half to two or three hours after meals, in the region of the duodenum, extending downward and backward toward the right kidney, and simultaneously upward to the right shoulder. It is often felt on the dividing line between the epigastrium and right hypochondrium, but seldom in the epigastrium alone. Unlike the pain of gastric ulcer, it is rarely referred to the back. In character it varies, being dull or acute, of increasing or decreasing violence, constant or intermittent and paroxysmal, relieved or aggravated by pressure. It is less constant and intense than is the pain of gastric ulcer, and, unlike this latter, again, is increased when the patient lies on his right side. It is comparatively rare to find it confined to a circumscribed spot in the right hypochondrium in the vicinage of the lower surface of the liver, but when so found it is of maximum diagnostic importance. The pain is sometimes of a most violent character, causing the patient to scream and to seek rapid changes of position in search of relief.

Hemorrhage is very common, and according to both Krauss and Oppenheimer occurs in at least one third of all cases. It is often unnoticed, as the blood, much altered, passes in the stools. Bleeding may occur gradually as capillary oozing, or the quantity may be large from erosion of some large vessel. When of moderate severity there are abdominal symptoms simulating indigestion. Hæmatemesis is not apt to occur except when the hemorrhage is great, and is then unusually sudden and copious. Attacks of it have happened from one to fifteen years before death.

Melæna is somewhat more frequent than hæmatemesis, the relation being as 5 to 4. The blood during its transit through the bowel is always digested, and is expelled in black, rarely red, masses mixed with fecal matter or distinct and separate from the fæces. The color is so like that of fecal matter darkened with bile, bismuth, or iron that an error is often made. If the hemorrhage has been great or continued, large passages from the bowel may consist of nothing but blood. In this case the vessel may be one third filled with a homogeneous, tarry mass, easily mistaken for fecal matter. Hemorrhages lead to progressive anæmia and debility, or to sudden anæmia and collapse symptoms. They are the immediate cause of death in about 14 per cent. of the cases.

Perforation is common, and is by far the most dangerous event in the course of the disease, being almost invariably fatal. Very few recoveries have been recorded, and in these, with one exception, death ensued a short time later from intercurrent complications. Of 262 cases reported by Collins, perforation occurred in 175. The symptoms attending this event are those accompanying perforation elsewhere—pain, perhaps vomiting and tympanites, with collapse. Of 41 cases, 24 died in the first twenty-four hours, 9 on the second day, and in only 4 was life prolonged beyond one hundred hours. What proportion of these cases offered symptoms that would have led to a diagnosis some time before death is not known.

The urinary analysis is of merely confirmatory value, and some authors deny even that. When typical, the urine is dark yellow, sometimes milky or dark brown, and its specific gravity, because of an increase in urea, is high.

Complications and Sequelæ.—These are comparatively few. The most important is stenosis from cicatricial contraction, which is especially liable to occur if there have been multiple ulcers in the upper third of the gut. When occurring above the papilla of Vater, as it does in all typical cases of ulcer, the condition can seldom be diagnosticated from stricture of the pylorus p. 141. Another sequela is obstruction of the common bile duct by cicatrization of ulcers which have extended to this locality. Fistulæ occasionally form between the lumina of the duodenum and colon, or between those of the duodenum and gall bladder. In 5 cases, collected from the entire literature upon the subject, it is reasonable to suppose from the symptoms and physical signs that cancerous infiltration in the locality of the ulcer had occurred. In only two of these cases were post-mortem examinations permitted; in both the diagnosis was verified.

A most interesting complication of this disease, and, fortunately, an extremely rare one, is progressive pernicious anæmia. Apparently it is due to two complementary factors: (1) repeated hemorrhages occurring with such frequency that they exhaust the reparative functions of the blood-making organs; and (2) disturbances of nutrition which result directly from the duodenal lesion and aggravate the exhaustion due to hemorrhage. The clinical picture in the two cases which Devec has collected is typical.

Peritonitis is a condition usually seen only after perforation, and when circumscribed and attended by the formation of plastic lymph is rather an attempt toward reparative processes than a true complication. The attempt, however, except in four cases collected, ends as such, and death usually occurs in from eighteen to twenty-four hours. In a case reported by Lockwood, the history and autopsy led to the inference that for six years a sac of plastic lymph, resulting from peritonitis after perforation, had shut off the lumen of the duodenum from the general peritoneal sac.

Diagnosis.—The lesion most frequently confounded with duodenal ulcer is gastric ulcer. The points of chief differential value may be tabulated as follows:

Duodenal Ulcer.	Gastic Ulcer.
1. Occurs most often in men.	1. Occurs most often in women.
2. Pain (in typical cases) in the right hypochondrium from one to three hours after meals. Pain in back very rare.	2. Pain under ensiform cartilage or in left epigastrium. Usually at once after eating. Pain in back very common.
3. Dyspeptic disturbances rare. Vomiting, with pronounced cardialgia, rarer than in gastric ulcer.	3. Dyspeptic disturbances generally present. Vomiting, with cardialgia, common.
4. Hæmatemesis rare.	4. Hæmatemesis common.
5. Melæna common.	5. Malæna rare.
6. Icterus commoner than in gastric ulcer.	6. Icterus almost never occurs.
7. Frequent after extensive burns of body.	7. Very rare after burns.
8. Perforation and peritonitis very common.	8. Perforation and peritonitis more uncommon.
9. Duration of chronic cases, months to many years.	9. Duration less; progress more rapid.
10. Test meal less characteristic.	10. Test meal more characteristic.

Cases in which duodenal pain of chronic, intermittent character is the only symptom may be mistaken for gastralgia or enteralgia, but these conditions are more common in women, and are associated with neurasthenia, uterine disease, anæmia, chlorosis, malaria, or cold. They bear no relation to the taking of food, and are not increased by pressure.

The pain of chronic intestinal indigestion is not so severe nor so circumscribed, and is accompanied by borborygmi and occasional diarrhœa. Acute intestinal colic may be recognized by the etiology, time of occurrence, seat, character of the pain, and subsequent history. There are other lesions, as jaundice in the one case and the escape of a calculus from the bladder in the other, mesenteric or visceral cancer, which may be attended with pain in the same region, but the progress of the case, the growth of a tumor, and the emaciation would clear up this point.

In a certain number of cases where the symptoms are latent a diagnosis is impossible up to the moment of a profuse intestinal hemorrhage. The character of the blood passed, and the exclusion of other sources of hemorrhage by the negative character of the history, may justify a diagnosis from this symptom alone.

In those suspicious but indefinite cases following a somewhat atypical course in which there suddenly appear symptoms of perforation a diagnosis may often be made. But the sudden onset of such symptoms without a suspicious history should not lead to a dogmatic diagnosis. There are too many causes of peritonitis by perforation, and perforation by duodenal ulcer is too rare, for one to diagnosticate with certainty, though the possibility of its occurrence should always be borne in mind. Significant facts are that the symptoms come on suddenly two or three hours after meals in persons apparently in good health, and that the pain is almost invariably under the liver in the right hypochondrium. These are the only diagnostic elements, but there is scarcely any other lesion which, after so latent a course, will give rise to perforation. In some cases the symptoms have simulated acute hemorrhagic pancreatitis, intestinal obstruction, acute retention of urine, or lead colic. Often a diagnosis in these most obscure cases is impossible until after the sectio cadaveris.

One would be justified in making a diagnosis of duodenal ulcer if a man, otherwise in good health, between thirty and forty years of age, suffers from attacks of severe pain below the edge of the liver to the right of the median line, the pain coming on from two to four hours after meals, lasting from two to four hours and then gradually lessening. Such a symptom, without gastric indigestion or the evidence of any organic lesion, pursuing a chronic course during a year or more, with remissions and exacerbations according to the simplicity or indigestibility of the diet, could be reasonably attributed to duodenal ulcer as a cause. This diagnosis would be confirmed by the occurrence of intestinal hemorrhage of the character described, or of perforative peritonitis.

Prognosis.—An unfavorable termination has been thought to be the rule, but this opinion was based on an imperfect knowledge of the disease. It is now known to be frequently not recognized until at the autopsy cicatrices of healed ulcers are found. If a diagnosis could be

made early, so as to begin a proper treatment, there is every reason to think that the results would often be successful. The recovery, as evidenced post-mortem, of many untreated cases would substantiate this fact. But the most favorable cases may suddenly take on aggravated symptoms, and there is constant danger of hemorrhage or perforation, for neither the depth of erosion nor its proximity to large vessels can be conjectured from its clinical course. At best, the course of the disease is usually irregular; when most unexpected favorable or unfavorable conditions may arise, so that a definite prognosis in any particular case is impossible. Only in general terms can it be stated that those cases which offer a chronic course will usually pass on to recovery, and that those whose clinical history is signalized by an abrupt onset will generally terminate unfavorably. Recurring profuse hemorrhages indicate a large growing ulcer. What opinion may be based upon the intensity of the pain is not determined.

Treatment.—The seat of the lesion below the pylorus differentiates its treatment but slightly from that of gastric ulcer. In the former case the return to a more liberal diet is possible much earlier than in the latter. Cicatrization is hastened by rest both of the body and of the viscus involved, so that hygienic measures form a large part of the treatment. Rest and an exclusive milk diet kept up for a long time are essential measures. Yet, though milk contains all the elements necessary to nutrition, in some cases it is distinctly injurious because of the character of the gastric juice. It must not be forgotten that much of the digestion of milk is carried on below the papilla of Vater, and that it often leaves the stomach in small curds which are capable of much mechanical irritation. Predigested milk may, therefore, be needed. Beef, chicken and other meat extracts which may, in large part, be assimilated by the stomach, will often be well borne. Albumen water is also excellent. Food must be given in sufficient quantities to sustain nutrition, for the danger of anæmia and emaciation is extreme, and, as observed by Luttke in his experiments upon duodenal ulcer artificially produced, repair is much more protracted in debilitated conditions.

Donkin suggests absolute rest of the stomach for a period varying with the duration of the disease and the severity of the case. Excepting narcotics only, nothing is to be given by mouth in any case. Rectal feedings, at intervals of from two to six hours, should consist of 75 grammes of beef or other meat extract, alternating with 15 grammes of brandy, with opium or belladonna in appropriate dosage if the part becomes irritable. In cases treated in this manner everything progresses satisfactorily, and after three weeks at the farthest a little milk or bouillon may be given by mouth, but the enemata are still continued. These are progressively diminished, however, both in frequency and amount, so that after from four to five weeks all aliment is assimilated by the stomach. In the course of this treatment the patient loses flesh very considerably, but by absolute repose this is prevented from progressing very far, and after recovery flesh is very quickly taken on again. Despite this nutritional retrogression this method has been successful in several cases that would yield to no other treatment.

When hemorrhage occurs, ice is given, with opium, ergot, acetate of lead, etc., and the ice bag is applied externally. Aliment should be given

by the rectum only until the patient has reacted well. Copious enemata of hot normal salt solution, or venous or subcutaneous transfusion, will assist in bringing about this result.

It is doubtful whether there is any remedy which favors cicatrization by its local effect, unless nitrate of silver may be said to have this property. Bismuth, chalk, bicarbonate of soda, or more especially sulphate of soda, as recommended by v. Ziemssen, pancreatin, pepsin, etc., which have a beneficial influence only by their influence upon gastric secretion, have been tried and recommended. Salicylate of bismuth is a remedy that has lately gained a favorable reputation in this connection.

When general peritonitis occurs from perforation, laparotomy, suturing of the wound after excision of the ulcer, and a general lavage of the abdominal cavity are indicated. This has been practised four times, once with success. When the peritonitis is circumscribed, the appropriate treatment is evident, and that it is not reprehensible, though a forlorn hope, is evidenced by Luttke's case (among others), in which recovery ensued after the evacuation of 500 grammes of pus.

BENIGN TUMORS OF THE DUODENUM.

Benign tumors of the duodenum are exceedingly rare. Those found in the museums are usually cauliflower-like, papillomatous masses near the opening of the bile duct or between it and the pylorus. Adenomata have been described, and one remarkable mass consisted of conglomerate racemose glands lying between the muscular bundles of the intestine. Many of these tumors produce no symptoms whatever; in other cases there is gastric indigestion with pain between the shoulders and tenderness over the umbilical region. In others, where the neoplasm is at or near the papilla of Vater, there occur jaundice, irregular pyrexia, and perhaps hemorrhage. A diagnosis depends upon the symptoms of progressive obstruction and the perception of a mass in the region of the duodenum. The course of the disease is usually (if it has given rise to any symptoms at all) quite irregular, and occasional periods occur when all symptoms disappear entirely. Death ensues in from three months to two years. The treatment is surgical.

CANCER OF THE DUODENUM.

Etiology.—The comparative rarity of primary malignant disease of the duodenum may be estimated from the report of 1800 autopsies upon persons dying of all diseases, in which this lesion was found in 10 cases only. Nevertheless, the duodenum is more frequently the seat of carcinoma than any other portion of the intestinal tract except the rectum. Of 12 cases in which the small intestine was primarily in-

volved, the duodenum was the seat of the neoplasm in 9, and fully one third of all primary cancers involving the gut between the pylorus and the sigmoid flexure are located here.

Heredity is said to have some influence. There is usually an antecedent history of chronic indigestion. Males are more frequently affected than females in the proportion of three to one. The average age at death in cases of carcinoma is forty-eight years, but in one case it was twenty-seven, in another eighty. In sarcoma the average age at death is thirty-one. Secondary growths of malignant disease in the duodenum due to metastasis are rare, but secondary disease by extension from contiguous parts is half again as frequent as primary disease. Usually such extension is from the pancreas, lymphatic glands of the mesentery, or pylorus.

Pathological Anatomy.—Carcinoma of the duodenum is somewhat more common than sarcoma, and scirrhus is seen more often than the encephaloid or colloid forms. All forms of primary malignant growth are far more frequently found in the upper than in the middle or lower thirds of the duodenum, though any or all parts of it may be involved.

Carcinoma occurs either as a nodular mass, or more commonly as an excavated ulcer with elevated and thickened edges. The ulcerative process may extend deeply and lead to perforation of the gut or to the formation of fistulæ with adjacent cavities. In one case the mesenteric artery was eroded; in another a large extra-intestinal abscess was formed which passed downward and opened in the iliac fossa. Wherever located the disease has a tendency in most cases to spread in the mucous and submucous tissues, becoming annular or cylindrical. Sometimes the ring is incomplete, and there is only a plate of malignant tissue, but where the patient has not died of intercurrent disease a definite tubular shape is generally found.

At the site of the neoplasm, especially if this has been of rapid growth, the lumen of the tube is much diminished, being sometimes as small as a goosequill. Above it there is dilatation proportionate to the degree of stenosis. If the upper part of the duodenum has been involved the pylorus is patulous and the stomach dilated. Below the stricture the calibre of the tube is diminished.

Necrologists differ diametrically on the influence of carcinoma of the duodenum, *per se*, upon the common bile duct; some citing cases where it caused occlusion, others where it seemed to cause dilatation. In a certain proportion of cases occlusion does occur, but is then usually due either to extension of the disease to the head of the pancreas with consequent pressure, or to the wall of the duct. Jaundice, which occurs in about one third of all cases, is probably always due to occlusion.

In about 20 per cent. of the cases the disease has extended to the contiguous organs, pancreas, liver, biliary ducts, peritoneum, retroperitoneal glands, etc. Histologically, though differing in the amount of connective-tissue stroma and in vascularity, the growths originate from the crypts of Lieberkühn, or, in very rare cases, from Brunner's glands. "The essential constituent cells," says Pick, "generally present a clean outline, the protoplasm granular and scant, and the nuclei large, usually round and with one or two pronuclei. The cells arrange themselves in twisted, folded chains, or in irregular masses, in the centre of

which they have lost their definite cylindrical shape and undergone fatty degeneration."

Sarcomata show the same tendency to annular or tubular development as do the carcinomata, but in marked contradistinction they oftener lead to thickening and dilatation than to deep ulceration and stenosis. A general diffuse infiltration may cause a thickening of the wall as much as three fourths of an inch. The mucous membrane is sometimes found stretched over the growth; at others it is remarkably rugose, and the valvulæ conniventes, when specially affected, form thick encircling ridges. In other cases there is slight ulceration, but it is rare to see this extending deeply, though in one case it eroded the pancreatico-duodenalis artery. Occasionally sarcoma takes the form of isolated flattened or rounded nodules scattered through the duodenum. Unlike carcinoma, the immediate disease in the intestine does cause occlusion of the bile duct in at least one half of the cases, probably by thickening of the intestinal wall. In contrast with carcinoma also, secondary deposits by metastasis are frequent, occurring in about 85 per cent. of all cases. Usually the retro-peritoneal glands and kidneys are the parts affected.

The cells are round, of striking similarity to each other, and consist of a large nucleus colored in mass by carmine, with several nucleoli. The protoplasmic zone about these is extremely thin or absent. At no point in their evolution are these cells fusiform or cylindrical; they give rise to no secretion, but form a mass in whose depths there is a characteristic embryonic network of connective tissue.

Symptoms.—Cancers of the duodenum present two trains of symptoms: (1) Those which occur in common in all cases; and (2) Those dependent upon the location of the neoplasm.

The symptoms common to all forms are progressive emaciation and cachexia, with an anæmic tint or pigmentation of the skin; digestive disturbance, characterized by anorexia, vomiting of an extremely variable nature, occasional hæmatemesis (the blood being usually altered), and in most cases intestinal symptoms, consisting most frequently of constipation alternating with diarrhœa. This last may be the only indication of intestinal disease.

Pain is invariably present in the epigastrium or in the right hypochrondrium; in one case it was referred to the left hypochrondrium in the axillary line. At best, pain is a very uncertain element in the diagnosis or localization of the disease. There is also increased sensibility to pressure.

In about one half the cases there is a tumor of variable mobility, usually seated a little below and to the right of the epigastrium, and evident only on deep palpation. Frequently there are signs of gastric dilatation and a slight ballooning of the epigastrium which contrasts conspicuously with the retraction of the rest of the abdomen. As a rule, there is no indication of stenosis of the bile ducts.

These diverse symptoms have a value only when associated, but present nothing pathognomonic.

The symptoms peculiar to neoplasms when localized definitely depend upon its situation, above or below the papilla of Vater. When above the diverticulum there is usually a history of chronic dyspepsia, and the

transition from health to disease has been slow and insidious. There is epigastric flatulence with a sense of weight and fulness after meals, abdominal pain, sharp and circumscribed (at first vague and dull), usually occurring at about from one to two hours after meals. Then eructations and vomiting supervene. In other rare cases the patient has presented no symptoms whatever until the appearance of persistent vomiting, flatulence, and acute, violent pain in the epigastrium. Occasionally, progressive asthenia and emaciation are the only symptoms.

In typical cases, until in advanced stages, the stomach is usually regarded as the part diseased. Pain is referred to the epigastrium, or to the vicinage of the dividing line between this and the right hypochondrium. It gradually increases in intensity until vomiting occurs, when it is relieved. In this, and in its frequently periodic or spasmodic character, it suggests stenosis of the pylorus. This periodicity is due to reflex spasm of the muscular wall of the stomach, a condition sometimes so intense that it is perceptible to the hand. The nature of emesis varies according to the stage of the disease. At first it is slight and occurs only after long intervals, but these gradually shorten, and when the disease is well established vomiting is almost constant. Later, again, vomiting is rare or may be absent altogether. Loss of appetite, however, continues. There is intolerance for meats more than for any other food, but not to such an extent as in gastric cancer. The abdomen is generally flat, except in the epigastrium, where slight meteorism is always evident. A deep, methodical palpation will reveal, in about one third of the cases, a movable tumor lying to the right of the median line between the lower border of the thorax, the umbilicus, and the gall-bladder. As a rule the bowels are constipated, but the stools are not decolorized.

When vomiting appears, the course of the disease is accelerated; it may be complicated by purpura or cardiac weakness. Apyrexia is the rule, but in some cases there is high, irregular fever, due to the resorption of the products of bacteriological activity or to vegetation and necrosis of the neoplasmic masses. Death usually occurs in from seven to eight months.

When the cancer is below the papilla of Vater the symptoms are the analogues of those mentioned above, except in a few details. Bilious vomiting, which is very rare in cancer of the first part of the duodenum, occurs in this form, owing to the bile passing into the stomach by regurgitation. However, many sarcomata below the diverticulum cause dilatation of the intestine at the site of the disease, and bile, though present in the vomitus, is found in far smaller amounts than when stenosis occurs. Hydrochloric acid is found free in the vomitus or not, according to whether bile is absent or present in the gastric contents. An important fact in this connection is that a short time after thorough gastric lavage, and before food has been again taken, chyme regurgitated from the duodenum may be withdrawn from the stomach. The bowels are extremely constipated, and the stools somewhat decolorized and offensive. A small, immovable tumor is usually noticed on deep palpation in the lower duodenal region.

In all cases of periampullar cancer vomiting, flatulence, and other signs of gastric dilatation are dominant symptoms. Icterus, with con-

comitant signs of lack of bile in the intestine, is present in the majority of cases, and comes on either suddenly or gradually. Distention of the gall bladder, fever of an intermittent type, and fetid, fatty stools are often seen. It is only in rare cases that a tumor may be made out, for when the neoplasm is located here death results usually from peritonitis at an early stage of the disease.

Diagnosis.—A differential diagnosis of the "sus-Vaterian" cancer from cancer of the pylorus is extremely difficult. Indigestion of albuminoids and fats is less marked in this form than in gastric cancer. On *à priori* grounds it would appear that an examination of the gastric juice would give important indications of the location of the growth, but the coexistence of dilatation of the stomach and gastric fermentation complicates the situation greatly. Thus, in some cases of duodenal cancer there is an utter absence of free HCl, a very small quantity of combined HCl, but a large amount of organic acid, a condition occurring in carcinoma ventriculi and in some cases of duodenal ulcer. Insufflation of the stomach has not yet been employed, and, because of the almost invariable pyloric insufficiency after a certain time, it is doubtful whether this procedure would be of use when a diagnosis is most difficult. On theoretical grounds only is the method of value early in the disease.

Many cases of duodenal disease have their origin by extension from gastric tumors, and the recognition of such extension is usually not made until the autopsy.

A diagnosis of the exact location of the neoplasm, whether at the pylorus or in the upper part of the duodenum, is usually unnecessary if its existence can be determined early enough in the disease for extirpation.

Ulcer of the duodenum offers in many cases either a definite etiology or a latent course suddenly becoming evident; it is oftener accompanied by hemorrhage and severe paroxysmal pain, is not so often attended with vomiting, presents no tumor, is not characterized by such cachexia, and runs an entirely different course.

Chronic duodenitis offers early symptoms of jaundice, has a more diffuse pain, often accompanied by exacerbations of fever, is not associated with a tumor or profound changes in the gastric juice, and is amenable to treatment by diet.

Stenosis of the pylorus, whether from intrinsic or extrinsic causes other than cancer, is unaccompanied by cachexia, hæmatemesis, or characteristic changes in the gastric juice; the dilatation of the stomach is usually greater, and a significant history is reported.

Ulcer of the stomach occurs most frequently in women, at an earlier age, is usually unaccompanied by tumor, though induration may be felt, and is accompanied by hyperacidity of the gastric contents. In ulcer severe pain occurs soon after eating, and is sometimes relieved thereby. Vomited blood is great in amount, and sensitive points, corresponding to the seat of the ulcer, may be determined on palpation. Atonic dyspepsia with gastralgia is not accompanied by tumor or the significant changes in the gastric juice, but by neurasthenic symptoms. It occurs most frequently in women; the pain is not so definitely localized, and bears no constant relation to the ingestion of food.

Of the intrinsic causes of duodenal stenosis, cicatricial contraction is the most common. In such cases a history of syphilitic, tuberculous, chemical, or simple ulcer is usually obtainable. As, however, extensive ulceration may exist, and throughout its course be entirely latent, stenosis has often resulted from unsuspected cicatrization. Spasmodic narrowing of the duodenum has been recognized as a part of a general neurosis. Obstruction by biliary calculus is preceded by signs of biliary lithiasis and biliary colic. Duodenal benign tumors are exceedingly rare, and generally they do not run so rapid a course, are less painful, and are less frequently accompanied by hemorrhage or intestinal indigestion.

Extra-duodenal causes of stenosis are numerous. A circumscribed peritonitis with exudate compressing the intestines is generally accompanied by more acute pain on pressure, and in the great majority of cases results from inflammation of the gall bladder. "Tumors of the mesentery, hydronephrosis, cysts of the right kidney, hydatid cysts or other tumors on the lower surface of the liver, aneurysm of the abdominal aorta, deep phlegmon of the abdomen, and many tumors of the abdominal wall have been associated with symptoms of duodenal occlusion. But in all cases the comparative mildness of the intestinal symptoms and the diversified signs previously calling attention to some other viscus (*e. g.* urinary troubles in hydronephrosis) should suggest some extrinsic cause of stenosis. An attentive study of the connections of the tumor, of its seat, its mobility, its excursions with respiratory movements, its sonority, etc., phenomena all varying according to the peculiarities of each particular growth, will perhaps indicate the true condition" (Pick).

It is well to remember that displacement of an abdominal viscus (particularly the kidney) will cause stenosis of the duodenum. In one instance it was due to prolapse of the pylorus permitting the bile to readily flow into the stomach and thus occasion violent, continual vomiting. The symptoms were promptly relieved by the use of an abdominal binder. Nicaise and Glénard state that exaggerated tension of the mesentery will obliterate the canal of the third part of the duodenum. In these cases a diagnosis lies along the lines indicated above, and absence of cachexia with occasional hemorrhage or melæna implies the absence of cancer.

Infra-duodenal stenosis, whether due to benign or malignant growths, is always accompanied by much general ballooning of the abdomen, while in duodenal cancer, whatever its exact seat, this is slight and confined to the epigastrium, the rest of the abdomen being retracted. In duodenal cancer constipation is the rule. Blood, if found, is altered in color, but is never in large amount, as in duodenal ulcer.

Cancer of the head of the pancreas rarely or never occludes the gut; in most cases vomiting is either slight or is more frequently absent. Hemorrhage is excessively rare until the gut has been invaded, and there are few of those symptoms of gastric intolerance which play such a conspicuous rôle in the course of cancer of the duodenum.

If the neoplasm is around the diverticulum of Vater the symptoms are multiform, for, independently of the common evidences given by all malignant growths, they are in the main the same as if the cancer were

located above and near the pylorus or below the ampulla, the preponderance of either train of symptoms depending directly upon the location of the greater part of the growth. In either event, however, icterus occurs in a large proportion of cases, and this, with the symptoms detailed under supra- or infra-ampullar cancer, will determine its exact location and diagnosis.

PROGNOSIS.—Death usually takes place in seven or eight months, but in one case it occurred as early as the third, in another as late as the fourteenth month.

TREATMENT.—There is apparently no reason why excision of the growth should not be practised with the same hope of success as attends operation for similar conditions in the stomach or other parts of the abdominal cavity. Doyen has reported a case where excision of pyloric cancer, and of duodenal cancer which was due to its extension, was practised with a favorable result. But while this operation may be possible if the neoplasm be in the first or third portion of the gut, gastro-enteric anastomosis is the only intervention possible if it implicate the second portion. Indeed, because of proximity of the duodenum to the pancreas, liver, and gall bladder, and the possibility of extension of the disease to these parts before an operation is consented to, French authors affirm that this latter operation alone is justifiable wherever the neoplasm may be located. Though so broad a conclusion is unjustifiable, it emphasizes the necessity for an early diagnosis and prompt intervention by as radical a means as the circumstances of the case will allow.

INTESTINAL INDIGESTION.

BEFORE the phenomena of intestinal indigestion can be fully understood, there must be a clear idea of those processes of digestion which normally occur. To this end a short résumé of the most essential facts will be given before the immediate subject itself is discussed.

Digestion begins in the mouth under the action of several salivary ingredients, the most noteworthy of which is ptyalin. This is an unorganized ferment or enzyme of the amylolytic or diastatic group, which has the property of causing successive hydrolytic splittings of the starch molecule, so that the conversion of starch into sugar is indirect, through several forms of dextrin. The sugar that is ultimately formed was until recently supposed to be grape sugar, or dextrose ($C_6H_2O_6$), but experiments now show that it is maltose ($C_{12}H_{22}O_{11}H_2O$), which is more closely related to cane sugar. As rapidly as formed the products of ptyalin digestion are removed by dialysis if sufficient time be given; this is practically instantaneous upon the part of the starchy food with which ptyalin comes in contact if the capsules of the starch grains be broken. There is rarely enough trituration in the mouth to bring about complete digestion of all the starchy food taken. Within certain limits the time necessary to effect the transformation varies inversely as the quantity of the enzyme, but no secretion is sufficiently profuse to act thoroughly in the mouth alone unless mastication is adequate.

The opinion formerly held that the action of ptyalin is at once checked in the stomach is based upon the fact that free hydrochloric acid, in the test tube, to the extent of only 0.003 per cent. (Chittenden) will practically stop all amylolytic action. Later experiments, however, by the same investigator show that this not only does not occur in the gastric juice, though it should contain 0.05 per cent. of the acid, but that in this medium, in the early stages of digestion, the ferment is much more active than under other conditions. Salivary digestion of starch is only commenced in the mouth, for it continues in the stomach for about half an hour. It is then stopped by the acid proteids, fatty acids, or large amounts of hydrochloric acid. It is noteworthy that ptyalin and its correlative ferments are not found in the saliva of infants under from three to six months of age.

Gastric digestion is due chiefly to the action of pepsin and rennin in a solution acidified by free and combined hydrochloric acid. Pepsin is a typical proteolytic enzyme which has the peculiarity of acting only in acid media. Peptic digestion therefore, properly considered, is the result of the combined actions of pepsin and HCl. By it solid or liquid proteids are split up into simpler substances which are rapidly diffusible through animal membranes. The ultimate end-product is peptone, but this is the result from the successive metamorphoses of several intermediary substances. The proteid is first converted into acid albumin or syntonin by the combined action of the acid and the ferment, the importance of the former here preponderating. Syntonin now takes up water, and two simpler proteids, known as primary albumoses or proteoses, are formed. Each of these again undergoes hydrolytic cleavage, forming secondary or, as they are now called, deutero-proteoses. Finally these disintegrate and peptone is formed—the limit of gastric digestion. From the formation of syntonin the process is merely that of a succession of hydrolytic changes whereby soluble proteids are reduced to smaller and smaller molecular weights. The other most noticeable chemical differences between the mother proteid and the peptone are the lesser amount of carbon and the greater amount of oxygen in the latter.

Rennin is the gastric ferment whose sole function appears to be the coagulation of milk. When this is ingested it undergoes a process strikingly similar to the clotting of blood, both in its superficial characteristics and the nature of its chemical changes. Cow's milk sets into a solid clot, which shrinks and presses out a clear albuminous fluid, the whey, but human milk forms loose white flocculi, much softer and easier of digestion. Though thus far rennin has been the only active factor in digestion, here, at least upon the clot which has precipitated—*i. e.* the casein—its action ceases and the ulterior change into peptone is due to pepsin. Dilute acids coagulate milk with facility, and it has been suggested that coagulation in the stomach may be due in part at least to lactic or hydrochloric acid, but the far greater potentiality of rennin, and the greater digestibility of the clot which it forms, indicate that it is the only agent in the process.

Hydrochloric acid finds its utility in its disinfectant properties, and, as suggested above, in its influence upon the digestion of proteids. The gastric juice of healthy persons contains a variable number of varieties

of micro-organisms, but they are always present in small numbers, and experiments would prove that this paucity is due to the presence of the acid. Though several observers have found fungi which flourish in the normal stomach, it is noticeable that they do not change the character of the gastric juice, and it is possible that in limited quantities they may have some correlative function in digestion. We are continually introducing with our food mould and yeast fungi and bacteria, which but for the hydrochloric acid would set up fermentation of various kinds, or which, developing in the system, would be the cause of numerous zymotic diseases. Various bacteria—*i. e.* those of cholera, typhoid fever, tetanus, anthrax, and diphtheria—are destroyed or their growth prevented by the gastric juice, so that they only gain ingress when this secretion is in abeyance, as through the drinking of water between meals.

Beyond its liquefaction by animal heat, and the digestion of its capsule there is little change which a fat globule undergoes in the stomach. Starches likewise would appear to be little affected by the purely gastric secretion, though in some instances they have been rendered soluble or changed into erythrodextrin. Unboiled starch is certainly not altered at all.

A most important factor in digestion is the peristaltic movement of the stomach, whereby a thorough agitation of its contents is caused. Thus each fragment is brought in contact with its secretions and the stomach wall, through which, if digested, a part is readily absorbed. Water, many salts, sugars, and a few other diffusible substances enter the system in small quantities through the stomach wall, but the fats, starches, some albuminoids, and most of the peptones pass through the pylorus to be further elaborated and absorbed from the intestine. Gastric digestion lasts from three to five hours, and though small quantities of aliment may be passed through the pylorus at intervals during the process, the greater part, including all the fat, is expelled at once when gastric digestion is complete.

Recent observations show that gastric digestion is dispensable, or of subsidiary importance, for various animals in which the stomach had been extirpated thrived as well after as before the operation.

The complex diffluent mass that enters the intestine is destined to here undergo its most profound changes. It will be well to consider seriatim the effects produced upon it by bile, pancreatic secretion, and intestinal juice, all of which are agents in its digestion.

The first of the fluids, the bile, though containing practically no enzyme and therefore incapable of causing a decomposition of carbohydrates, proteids, or fats, plays an auxiliary but not unimportant part in the digestive processes here. Upon starches its action is practically *nil.* But when it comes in contact with the acid products of stomach digestion a precipitate is produced, composed essentially of unchanged native albumins, bile acids, and pepsin. The immediate result is the instantaneous arrest of peptic digestion and the establishment of conditions necessary for the proper exercise of pancreatic functions. Upon fats, however, rather than any other aliment, bile has its most noticeable action. The steapsin of the pancreatic juice, to anticipate somewhat, forms, from the decomposition of some of the fats, free acids, which,

combining in part with some of the alkaline salts in the bile, form soaps which emulsify the rest of the fat. Absorption of fats is thus permitted and is facilitated by the presence of the free acids from the bile.

Recent observations show that the bile is sterile, but this does not mean that it is antiseptic. The bacillus mallei, B. typhi abdominalis, B. coli communis, comma, spirillum, pneumococcus, etc. have all been found in it. Under conditions of digestion, however, there are formed free bile acids which do not exist before the bile comes in contact with the chyme, and these exert an antiseptic action which is at least strong enough under normal conditions to control the action of native or foreign germs.

The pancreatic juice is composed of water, salts, albuminoids, and its three specific ferments, amylopsin, trypsin, and steapsin. Amylopsin is the similar of ptyalin, but is much more powerful. Inasmuch as the starches form a large part of our diet and as salivary digestion of these, though important, is comparatively subsidiary, their digestion takes place almost entirely in the small intestine, and mainly by virtue of the action of amylopsin. A similar enzyme, however, is found in the pure succus entericus, but its action is supplementary. Both these ferments act in the same way as does ptyalin.

Tryptic digestion resembles peptic digestion in that it concerns the proteids, but the two processes differ in many respects. In the latter the hydrolytic changes are gradual and the successive steps in the formation of peptone can be easily traced, but in the former the solid proteid undergoes a transformation directly to secondary proteoses and the intermediary steps are skipped. Next amphopeptones are formed in all respects similar to the end-products in gastric digestion. Neither of these could be further affected by pepsin, but trypsin splits them into two constituents, hemi- and antipeptone, and further elaborates one of these (hemipeptone) into much simpler non-proteid bodies, most of which are amido acids. The final products of complete tryptic digestion therefore are antipeptone and a variety of organic structures, mainly these amido acids. The most easily separated of these acids are leucin and tyrosin, both capable of ready assimilation, but not so valuable in tissue reconstruction as peptone.

Steapsin is that ingredient of pancreatic juice concerned in the digestion of fats. Though it is commonly spoken of as a fat-splitting enzyme, it must not be supposed that it acts in this manner upon all fats present. Only a small portion is thus acted upon and disintegrated into glycerin and free fatty acids, but these help to emulsify the balance of the fats. Such emulsification is effected by the union of the fatty acid with alkaline salts, especially sodium carbonate, which are always present in the pancreatic and intestinal juices. But it is in the bile that these alkaline salts are so disposed that such union and consequent formation of soaps and emulsions most readily occur.

The succus entericus contains no agent which has direct effect upon either the proteids or fats, but by virtue of the sodium carbonate which it contains it is indirectly valuable in the emulsification of these latter. But upon carbohydrates its action is important, for it not only contains an amylolytic enzyme capable of forming maltose, but inverting enzymes which convert maltose into dextrose and cane sugar into dextrose

and lævulose. The disaccharids which form the largest part of our diet are cane sugar, milk sugar, and maltose, which last is also the commonest end-product in artificial digestion of starches. All starches and sugars (except lactose, which may be absorbed unchanged) are finally absorbed as dextrose, an ultimate form to manufacture which the action of the intestinal juice is necessary.

These phenomena of digestion occur chiefly in the small intestine. Though the process may be continued in part after the food has entered the colon, no new factors in digestion itself are here added, and the changes of general interest are chiefly concerned with the bacteriological decomposition. Many food products that have been formed higher up are here absorbed.

Of the absorption of peptones and proteoses, either in the large or small intestine, it may be briefly stated that this, greatly assisted by the epithelial cells, occurs directly into the bloodvessels. But at the time of such absorption these substances are radically changed into others which have not yet been isolated, but are probably native albumins or serum albumin. Water, salts and sugars also pass directly into the bloodvessels, osmosis in each case being assisted by the epithelial cells. The fat droplets are taken up and passed directly through the substance of the epithelial cells; thence they are conveyed through a fine reticulum into the lacteals and common duct.

The intestinal movements that are so necessary in digestion and absorption are controlled by nervous arrangements, but may occur independently of the nervous system. The ganglia of Auerbach and of Meissner in the intestinal wall are sufficient for the development of the peristaltic waves. Paralysis by section of the splanchnic leads to hyperæmia of the intestinal vessels and increased peristalsis; stimulation of the splanchnic causes anæmia of the intestinal wall and immediate arrest of movement.

As has been suggested above, the gastric juice has a noticeable influence in destroying putrefactive and many pathogenic organisms which find their way into the stomach. All fermentations and putrefactions which there occur, with only possible minor exceptions, are normally due to enzymes. But in the small and much more so in the large intestine the conditions are more favorable to the growth of microbes, and hence, side by side with the digestive processes properly so called, others due to these agents are going on. In man organized ferments play a secondary part in the processes in the small intestine, and digestion appears to be most typically physiological when their activity is least conspicuous and when certain at least of the products of their activities are smallest in amount. Though many alkaline salts are found in the intestine, and though the secretions in it are alkaline, it has often been shown that the reaction of the intestinal contents is acid. Possibly this is due to the formation of amido acids by trypsin or to the disintegration of bile, or normally in slight degree to bacteriological activities. At any rate, all of these have a distinctly destructive and inhibitory influence on the development of all micro-organisms.

It is a strange and puzzling fact that the hydrobilirubin, the indol, skatol, and phenol which are the results of the putrefaction which goes on in preponderating measure, if not exclusively, in the large intestine

should be in part absorbed, and after entering the portal blood make their way through the liver and be excreted somewhat modified in the urine. That these bodies play a part in influencing the metabolic processes of the body scarcely admits a doubt. The phenols, the indol, and even the fetid skatol, all resulting from the lifework of putrefactive bacteria, illustrate the general law that the products of living organisms are prejudicial to and capable of destroying organisms of the kind which produced them, for all these bodies are more or less antiseptic.

Etiology.—The causes of intestinal indigestion may be predisposing, primary, or secondary. For convenience and to avoid repetition the two last may be considered together.

Predisposing Causes.—(1) *Age.*—It is usually said that though the condition may occur at any age it is commonest between the thirtieth and fortieth years. Though undoubtedly this is the case with adults, yet the prevalence of the disease among children is such that certainly they are to be considered more subject to it than older persons of any age. A United States census report shows that 76 per cent. of all cases of death from intestinal diseases occur before the tenth year. Many cases of so-called intestinal catarrh are really cases of intestinal indigestion, and the catarrh is secondary. It is with reason that the second summer of dentition is regarded with most apprehension by both mothers and practitioners, for it is then, when debilitating influences and those favoring the decomposition of food and multiplication of micro-organisms are most potential, and when the child is accommodating itself to a new dietary, that its digestive organs have not yet undergone the development necessary to new requirements. At this time putrefactive or fermentative bacteria can easiest effect an entrance and lodgement.

(2) *Sex* has little or no influence. Intestinal indigestion is more frequently seen in men, but is rather the result of personal habit than of any sex predisposition. Overeating and eating of indigestible food are especially vices of men.

(3) *Heredity* of idiosyncrasy in some few instances plays an important part. Almost every practitioner has seen cases in which the use of some particular food, as eggs or shellfish, is invariably followed by acute intestinal indigestion. Occasionally every member of a family may have the same idiosyncrasy.

(4) *Previous attacks* of intestinal indigestion may be said to predispose to others with the same liability as exists in all catarrhal inflammations. Although most cases of intestinal indigestion that call for treatment are subacute or chronic from the outset, there are many whose beginning may be traced to a few closely succeeding occurrences of the acute form.

(5) It is closely connected with the *neurasthenic constitution*, whether as effect or cause is not always clear.

The following are primary and secondary causes of intestinal indigestion:

1. *A Faulty Composition of the Chyme.*—A satisfactory condition of this mass is dependent upon the character of the ingesta and the manner in which they have been disposed of by the mouth and stomach digestion. "Both in regard to his digestive juices and the alimentary

principles submitted to their operation man does not differ in any essential particulars from the lower animals, and yet it would seem as if the function of digestion were less perfectly adjusted and its equilibrium more easily disturbed in man than in them. The cause of this discrepancy is to be sought for partly in the quicker and more universal sympathies of his nervous system, and partly and chiefly in the extraordinary complexities which civilized man has introduced into his dietary. He has departed and is departing more widely from the simplicity and uniformity of primitive natural life. Scarcely any two of his meals are exactly alike, and although the adjustive power of his digestive organs keeps pace in the main with this increasing complexity, the process of adjustment in many individuals seems to lag a good deal behind their requirements" (Sir Spencer Wells). On the other hand, a monotonous diet is noticeably conducive to intestinal derangements, especially if the few things taken are in any way difficult of digestion. Milk is the only substance containing all the elements in such proportion as the economy approximately requires, and it is for this reason that it only can be taken by most persons for long periods with any degree of satisfaction. The digestive secretions correlate each other; there is a variable though definite limit which they may hold each to each. Too much demanded of one class of digestive ferments—the amylolytic, for example—to the partial or complete exclusion of the others will first fatigue and then disorder their secretion. A milk or liquid dietary prolonged beyond the first year is accompanied with a feeble digestion that becomes indigestion with the slightest provocations.

Overeating of proteids is a frequent cause of dyspepsia, for these, if they cannot be completely digested, are especially liable to permit the multiplication of micro-organisms. Too much starchy food, on the other hand, interferes first with gastric digestion of proteids, and, if it ferment in the stomach, produces there lactic and butyric acids sufficient to practically destroy the intestinal ferments when they reach them later.

Irregularity in the hours of eating and a faulty distribution of the amount of food disturb the harmony of digestion. Very light breakfasts and late and large dinners are distinctly injurious. Diners-out rarely go through a season without one or two internal revolts. The habit, now quite common in cities, of deferring the breakfast proper until midday leaves the system too long without support; intestinal indigestion is becoming common among those Americans who have lived abroad and adopted European customs.

The functions of buccal and gastric digestion have already been discussed. The chewing of tobacco, and to a less extent the habit of smoking, are causes of deficient, altered, or depraved saliva, and secondarily of altered pancreatic secretion. Hasty mastication results in imperfect trituration of the starch granules, a deficient secretion of saliva, and consequent imperfect salivation. The wall of the starch granule, cellulose, unless broken by boiling or trituration is practically impervious to any digestive fluid, so that its contained nutritious elements are lost. The importance of thorough mastication is great—far greater than is realized by our patients. Too many cases of gastric or more especially duodenal indigestion are directly traceable to this

alone. Instead of an absorption of saccharine materials from the stomach, or even their formation there, the mass of undigested starch remains a dead weight, affecting the digestion and absorption of other aliments that should be disposed of here, and becoming soaked with fluids which will interfere with its own proper disposal later on. All the starch that has been eaten is often passed into the intestines, having undergone practically no buccal digestion whatever. The overstrained secretion of amylopsin, though able to rise to occasional emergencies, is unable to cope with continual demands upon it. Failure of its secretion is accompanied by failure of secretion of other ferments. Possibly the most prolific ultimate cause of intestinal indigestion is deficient mastication and insalivation of food.

The influence of gastric upon intestinal indigestion is important. A poor disposal of the proteids, hypoacidity favoring fermentation or putrefaction, hyperacidity with the early destruction of ptyalin swallowed with the food, too great sensitiveness of the stomach walls leading to evacuation of the viscus before gastric digestion is complete, and many similar and other conditions are first steps toward duodenal indigestion.

2. *Perversions in the Quality or Quantity of the Bile, Pancreatic, or Intestinal Juices.*—Hot weather, especially if associated with humidity, not only leads to indigestion by altering the food and preparing it for decomposition, but by debilitating the individual through the depression of the nervous system and by inhibiting secretory activity. The appetite, which, according to the demand upon it, has diminished *pro rata*, is often kept up to its former standard by will stimulation. The alimentary tract, though it contains no more than could be readily disposed of under normal circumstances, now retains a mass which the diminished secretions cannot digest and which ferments and putrefies. Sexual and emotional excesses, exhausting occupations, lack of sleep, grief, and mental depression, conduce to indigestion through the effect of their influence on the nervous system. Such occupations as horse-shoeing, tailoring, etc., in which the body is bent forward, tight lacing or other modes of compression, all cause a local anæmia and perverted secretion. Anæmia, rachitis, syphilis, continued febrile disorders, etc. often stand in direct etiological relation with the disease, and the connection of indigestion of fats with the strumous diathesis is so evident that Bennett ascribed the origin of phthisis to this defect. The influence of the mind upon intestinal is even greater than upon gastric digestion, for no other reason perhaps than that the former is a more complex function and less easily relieved than the latter. Prolonged or excessive mental labor does not do so much harm as worry, over-anxiety, and the high tension which a large or technical business demands. Professional men, who become overburdened with responsibilities and who sympathize too much with the distresses of others, or who have too many of their own, are very prone to suffer from this disease.

The precocious mental development of children is a fruitful source of indigestion. In short, the disease may be caused by any condition of the general organism which results in a depressed innervation or lessened blood supply of the intestinal glands.

Perverted intestinal secretion may also be caused by purely local

conditions. Intestinal catarrh is invariably accompanied by greater or less disturbances of digestion. The steps in the disposal of carbohydrates are much altered and the absorption of all aliment is delayed. Conversely, however, as suggested above, many cases of intestinal catarrh must be regarded as the result rather than the cause of intestinal indigestion. Disease of the pancreas or liver, cancer of the duodenum, fatty, sclerotic or amyloid degenerations, trauma, abscess, occlusion of the excretory duct of the pancreas or liver by catarrhal swelling, calculi, or the pressure of extrinsic or intrinsic tumors, or, in fact, any pathological condition of any one of these organs, is followed by intestinal digestive disturbances.

3. *Fermentation or Putrefaction of the Intestinal Contents.*—Decomposition of food may occur from the reciprocal action of several food stuffs upon each other, with the development of fatty acids, gases, etc. In some patients, substances that most persons can easily dispose of prove incapable of simultaneous digestion. But it is to bacteriological activities rather than to the influence of different aliments upon each other (for such influences are indefinite and capricious) that most fermentative or putrefactive processes, which assume pathological proportions, are due. Though such bacteriological processes occur to a limited extent, even in health, throughout the entire intestine, it is very easy for them to exceed those bounds which may be called normal. As stated above, digestion is probably most nearly perfect when the micro-organisms present are fewest and least active.

It has already been said that those agents which inhibit the over-development of bacteria are bile acids, the amido acids resulting from tryptic digestion, and, possibly, the acids resulting from the action of bacteria or fungi themselves. Since ptomaïnes are not produced under normal conditions in the intestine, these cannot be said to normally exercise an inhibitory influence. Hence the bactericidal factors of most importance are these: the bile must be of such a character that the bile acids can be readily formed; conditions favoring the formation of these acids—*i. e.* a normal chyme and pancreatic secretion must be present, and tryptic digestion be completed. These factors, though of continually varying proportional importance, should complement each other.

The number of germs in the intestinal canal is extraordinarily variable, so that one cannot fix upon a norm. Many things influence their number, such as the kind of food and length of retention of the intestinal contents, but it is probable that this latter is the chief influence. Of those that are found but a small number can be grown in ordinary culture media, and only the pathogenic bacteria of the intestinal canal, thus propagated, can be easily identified. They vary not only with the diet, but also with the methods of preparing food. Putrefactive and fermentative processes occur normally in the large intestine, but there the ultimate derivatives of digestion have already been formed and are being rapidly absorbed.

It is to the ptomaïnes of the micro-organisms and to the absorption of undue amounts of substances usually regarded as excrementitious, indol, skatol, etc., that most of the later phenomena attending intestinal indigestion are due.

It is to be remembered that practically all cases of intestinal indiges-

tion, however caused, are attended by a pathological multiplication of micro-organisms; that these, in the intestine, tend to perpetuate and aggravate the abnormalities which attended their origin; and that nothing which does not look toward their removal and the eradication of the products of their activities from the intestine and from the system can be expected to influence the course of the disease.

4. *Exaggerated or Deficient Peristalsis.*—Aliments primarily irritating or rendered so by faulty digestion exert upon the intestinal plexi a stimulating influence which is soon followed by exaggerated peristalsis. Under most circumstances this is beneficial, ridding the canal of deleterious matters. But when such peristalsis is due rather to over-sensitiveness, either from a general or local neurotic condition or from more gross local disease—*e. g.* ulcer, cancer, tabes mesenterica, inflammation, etc.—it often assumes pathological proportions. Deficient peristalsis may be caused by constitutional peculiarities, sedentary or irregular habits, drug-taking, general atony, peritoneal adhesions, chronic disease of the mucosa, or any of the many agencies that can cause stricture of the tube. The results are retention of food long after all nutritious elements have been absorbed, and decomposition of the residuum. Parasites then produce their specific ptomaïnes and elaborate by-products, which when absorbed may cause profound constitutional disturbance. The bacteria that multiply from the retention of food will also directly interfere with the proper digestion of subsequent meals.

5. *Defective absorption may follow local disease of the mucosa or a faulty elaboration of aliments by the digestive secretions.* The causes of this latter have already been discussed. Fat-absorption is especially affected by disease of the mucosa, for the cells then appear unable to take up the emulsion and pass it through their substance as they should. In this condition also the change of proteid derivatives into serum albumin and of the various forms of sugar into dextrose is imperfect or impossible. As these latter changes of the food, which occur partly in the liver, are not, properly speaking, steps in the immediate process of digestion, no further reference to them is here necessary.

Pathology.—Thus far acute and chronic intestinal indigestion have been treated for the sake of convenience as one disease, but from this point, except in those aspects which they have in common, they will be discussed separately.

The lesions described below are found in a limited number of cases, generally the severer forms, in which duodenal catarrh and indigestion have been coincident. It is reasonable to believe that the lesion in the acute form is slight in many instances, and that its duration is short.

Acute Form.—The mucous membrane is swollen and hyperæmic, varying in color from light rose to dark purple. This hyperæmia may be localized or diffuse or mottled, and is frequently much more severe in one part of the bowel than in another. It is usually most intense around the solitary follicles and Peyer's patches and on the tips of the valvulæ conniventes. Hemorrhages over an area one half a centimetre in diameter have been described. In mild cases the follicles and patches appear as small white bodies standing out in bold relief against the injected zone surrounding them; in severe cases they may become as large as a pea and are indurated and knotty. The surrounding inflam-

matory area may be necrosed and catarrhal, and follicular ulcers may form, but no deeper parenchymatous changes occur.

Microscopically the bloodvessels of the mucosa and submucosa are found more or less injected, and there are small extravasations, most frequently between the crypts of Lieberkühn. The interstices between them are often distended by the characteristic signs of a true inflammatory catarrh—the round cells. These are most numerous in the upper portion of the submucosa immediately beneath Brücke's muscles. The swelling of Peyer's patches and solitary follicles is due to proliferation of their own cells and a round-cell immigration. The epithelium of the mucous membrane is generally detached, and though this occurs post-mortem within six hours in many cases, it is probable, from correlative circumstances, that in this disease it is an ante-mortem change. The epithelium of the glands appears sometimes unchanged, sometimes opaque and swollen. Lieberkühn's glands are occasionally altered in position, etc.; they may be dilated throughout or only at the fundus, bottle-shaped, occasionally curled, and rarely raised or sunken. The deeper layers of the submucosa show hyperæmia with round-cell infiltration around the bloodvessels. There is no change in the muscularis or the deeper coats. The surface is covered with a variable amount of mucus. The mesenteric and less frequently the retroperitoneal lymph glands are enlarged.

Chronic Form.—In this condition the appearances are very similar to, or are quite identical with, those seen in chronic intestinal catarrh. The mucous membrane may be entirely unaltered, or pale and covered with mucus. More frequently, however, it is softened, of a slaty gray or bluish color, with grains of pigment in the villi and in and between the follicles. The lining epithelium has undergone fatty or granular degeneration and is shed over areas of variable extent. Hyperplasia of the connective tissue beneath the epithelium and of all lymphatic elements occurs, causing the closed follicles to project prominently above the surface. Eventually the walls of the entire intestine become greatly thinned or hypertrophied.

In this connection it would be well to mention *atrophia intestinalis*—a disease which may follow an acute or chronic intestinal indigestion (far more frequently the latter) or may come on insidiously. Microscopically there may be noticeable atrophy of the small intestine, whose mucous membrane, from the destruction of its villi, appears smooth and velvety. In the large intestine this appearance is absent. Desquamation of epithelium is not noticeable in the early stages, but as the disease progresses this phenomenon follows. The glands of Lieberkühn become smaller and shorter, until, from the continual compression of the interstitial tissue they disappear altogether. The villi undergo changes analogous to those in the glands—*i. e.* they become narrow, poor in cells, glassy, and finally cannot be recognized. The interstitial tissue spreads everywhere, but simultaneously contracts like cicatricial tissue, so that the entire area of mucous membrane is remarkably diminished. Next to the mucosa, the most profound change is seen in the muscular coat. The fibres there may be hypertrophied, but usually they are shrunken and in extensive areas have disappeared; in other cases they are separated by cellular infiltration or appear to be drawn rather than

forced apart. The ganglia of Meissner's and Auerbach's plexi undergo fatty degeneration.

The changes in the character of the succus entericus in each of these conditions must be profound, and the diminished powers of absorption, especially in atrophia intestinalis, would account for almost any degree of emaciation.

No changes in the pancreas peculiar to intestinal indigestion have yet been described, and the lesions of cancer and ulcer, in the course of which intestinal indigestion is incidental, are given elsewhere.

The exact alterations in the pancreatic secretions have also not been studied. It is known, of course, that one or all ferments may be abnormal, that they may be present in diminished amount or in excess, that the oscillations of the proportional relations between them (varying according to the character of the food) may not occur as they should, and that the potentiality of each or all may be diminished. In a general way the results of such abnormalities may be inferred, but of the ultimate chemical differences which they occasion, and which are of such great interest in auto-intoxication, we are ignorant.

What has been said of the pancreas and the pancreatic juices in this connection may also be said of the liver and the bile. This latter suffers remarkably little change even in advanced hepatic disease, and this change is not sufficient to cause much disturbance in intestinal digestion.

The character of the chyme when it leaves the pylorus varies widely within limits of health, but in almost all cases of gastric disease it is sufficiently altered to modify in part at least the processes of intestinal digestion. To detail the abnormalities of the chyme would be useless, but in general terms it may be said that they depend upon an excessive amount of hydrochloric or upon acetic, lactic, and butyric acids, various gases, chiefly hydrogen and carbon dioxide, large masses of sarcinæ and torulæ, and faultily digested proteids. What processes, then, transpire in the intestines should be evident from a review of the physiology of intestinal digestion. An excess of HCl is more easily dealt with than are the products of fermentation. The combined intestinal secretions may prove insufficient to lower the degree of acidity to such a point that trypsin will not be disintegrated.

But the most conspicuous chemical phenomena in both acute and chronic indigestion, and those that must be especially emphasized, are due to the activity of micro-organisms. Normally these are either absent from the small intestine, or if present their activities are feeble and not accompanied by the elaboration of ptomaïnes. In the large intestine there are fewer influences of an inhibitory character and several micro-organisms are normally found there.

Those agents which control bacteriological multiplication are the acids (lactic, acetic, etc.) normally set free in the digestion of food, and the bile acids, which are liberated as soon as the bile begins to undergo its physiological decomposition to aid in the emulsification of fats. It must be remembered that the normal reaction of the contents of the small intestine is acid (Gamgee); any condition, such as catarrhal, or nervous influence, etc. preventing proper digestive processes, and the proper formation of these acids will, therefore, directly conduce to the multiplication of germs, or their irruption may be so potential that all

usual means of resistance are overcome. The absence of ptomaïnes is due to the bile or the oxygen in the intestine. Normally there is a free diffusion of this element between the blood in the mucous membrane of the canal and the intestinal contents, and it is not until osmosis of this gas is seriously interfered with that ptomaïnes can be developed.

Numerous micro-organisms are capable of inducing putrefaction of albuminous substances, but those definitely known to play a rôle in intestinal indigestion are comparatively few.[1]

In the initial stage of this process aërobic and facultative bacteria usually play the most important part, while in active putrefaction they are supplemented or perhaps very largely replaced by "strict" anërobics,—organisms which have yet received comparatively little study. Among the facultative anaërobic bacteria perhaps the most important and ordinary exciters of putrefaction are bacilli of the proteus group; they are of common occurrence and possess to a high degree the power of causing putrefactive decomposition.

When intestinal contents and normal fæces are examined a very large number of micro-organisms are to be found. Even the milk fæces of sucklings are no exception in this regard, since normally at least two varieties of bacilli are present in them—namely, *B. lactis aërogenes*, which is more abundant in the small intestine, and *B. coli communis*, more abundant in the large. No true putrefaction occurs, however, for milk casein is not changed by either of these bacilli. In catarrhal enteritis the alvine discharges contain a much larger number of micro-organisms, while in diarrhœa associated with toxic symptoms one or more species of the proteus group (*ut supra*) appear to be constantly present. Thus the bacterial condition of milk fæces is comparatively simple, and well illustrates from a negative standpoint the relation between bacterial growth and some forms of intestinal indigestion.

[1] Over fifty known species of micro-organisms have been identified at various times in the fæces passed by patients suffering from intestinal indigestion and catarrh. The numerical relations between them are not always the same. The following bacteria that have been found in the large or the small intestine are most constantly present in the dejecta of such patients:

1. *B. Bischleri* (resembling the *B. coli communis*). Acts on grape sugar, forming ethyl alcohol, inactive lactic acid and acetic acid, and gas. No action on albumin.
2. *Streptococcus liquefaciens ilei.* Acts on grape sugar, forming inactive lactic acid; no action on albumin, but liquefies gelatin.
3. *B. ilei* (Frey). Decomposes sugar into succinic acid and active lactic acid and alcohol; no action on albumin.
4. *B. ovale ilei.* Decomposes sugar in the presence of paralactic acid; no action on albumin.
5. *B. gracilis ilei.* Acts virtually as *B. ovale ilei;* no action on albumin.
6. *B. liquefaciens ilei.* Acts on grape sugar only under favorable conditions; most vigorously on albumin.
7. *B. lactis aërogenes.* Acts on sugar, forming alcohol in large amounts, sarcolactic acid, succinic acid, and active lactic acid.
8. *B. putrificus coli.* Especially concerned in the decomposition of albuminous substances.
9. *B. coli communis.* Has an intense action on sugar, forming ethylic alcohol, acetic acid, and dextrogenous paralactic acid.
10. *Proteus vulgaris.* Liquefies gelatin and disintegrates proteids.
11. *Proteus mirabilis.* Liquefies gelatin and disintegrates proteids.

In addition to these micro-organisms, Nothnagel enumerates four different varieties of bacilli, nine cocci, and four fungi that are present, he says, simultaneously in some cases of intestinal indigestion.

The particular products formed by albuminous putrefaction will depend on the nature and condition of the proteid, the conditions under which it is placed, and the particular micro-organisms inducing the change. Toxic proteids are formed by bacterial growth, under certain conditions, both from living protoplasm and from proteids not associated with living tissues; but they are not normally found in acute putrefactive changes. The greatest resistance offered to albuminoid decomposition is in the initial stage of the process, the peptonization of the proteid, and if this be already completely accomplished by other than bacterial ferments (as in pancreatic digestion), then the conditions are much more favorable for active bacterial growth with the characteristic formation of ptomaïnes and other putrefactive products. Under the influence of trypsin part of the proteids are converted into amido acids, certain bases (lysine, lysatine, and ammonia), and tryptophan. Putrefactive bacteria cause first the elaboration of these bodies, or their activities may more easily begin at this point. Later other substances are formed, certain of which (phenol and paracresol) are the products of decomposition and the reduction and oxidation of tyrosin, while others (indol, skatol, skatol carbonic acid) are aromatic compounds not related to tyrosin. These represent the specific decompositions of the albuminous molecule distinguishing bacterial from tryptic proteolyses. In addition there are formed fatty acids, certain bases, nitrites, hydrogen, and hydrogen sulphide. The end-products are carbon dioxide, water, ammonia, nitrites, hydrogen, and hydrogen sulphide.

Unlike this decomposition of proteids, that of the carbohydrates is a normal process in the small intestine, but not to such an inordinate extent as may follow bacteriological activities. It is, in fact, upon carbohydrates that most bacteria exert their influence, as a glance at the appended list will show.

Though carbohydrates undergo four different methods of fermentation, it is sufficient here to state that the end-products of these are amylic, succinic, acetic, propionic, butyric, lactic, and paralactic acids, alcohols, and various gases, among which hydrogen, oxygen, and carbon dioxide are the most conspicuous.

In addition to these products and those mentioned as resulting from bacterial proteolyses, others distinctly poisonous are elaborated in the digestion of both proteids and carbohydrates, more particularly the former. No definite chemical formulæ for these (ptomaïnes, toxins, toxalbumins, etc.) can be given, but three general classes may be recognized:

1. Alkaloidal bodies composed of pyridin (C_5H_5N) or chinolin (C_6H_7N).
2. Diamins (putrescin, and cadaverin), as frequently demonstrated.
3. Toxalbumins—*i. e.* poisonous albuminous bodies.

The villi, weakened by contact with abnormal substances, are eventually paralyzed, so that they can no longer adequately exercise a discriminating inhibition upon the ingress of digestive products. The ready absorption of toxic materials is the result. Though these are normally found in the portal vessels in small amounts, they are then easily disposed of, in greater part at least, by the liver, for this organ has a distinctly destructive influence over almost all such organic

poisons. It is only when they are absorbed in large amounts, as after intestinal indigestion, that the hepatic functions prove inadequate; they then find their way into the general circulation, vitiating or at least impairing the nutrition of all tissues with which they come in contact. As will be shown in the discussion of urinalysis, certain toxic substances are normally absorbed from the intestine in small amounts, are passed through the liver and general circulation, and excreted by the kidneys.

Aside from general congestion there may be no lesions whatever discoverable after death from auto-intoxication. Tyrotoxicon, a product formed by the action of putrefactive bacteria upon cheese and to a less extent other proteids, has repeatedly been found in the tissues of persons dying through its immediate agency, yet it has seldom caused any gross lesions (in other localities than the intestine) that can be discovered by the most careful post-mortem examination. The same may be said of several other toxic substances occasionally elaborated in the course of intestinal indigestion.

In addition to those lesions in the intestine mentioned above there are some focal manifestations which may be summarized briefly: The superficial lymphatic glands are swollen and congested. The spleen is often much enlarged, tense, and deep purplish red in color. The kidneys are congested, sometimes the adrenals also. The mesenteric glands are swollen, œdematous and hemorrhagic. The liver is dark, often deeply congested, and presents to the naked eye foci of yellowish or yellowish white color which at times are surrounded by hemorrhagic zones. The microscopic examination of the lymph glands shows hemorrhages into their substance, many necrotic lymphatic elements, and rapid cell-multiplication by karyokinesis. The spleen undergoes similar changes. In the liver the capillaries are dilated and their endothelial cells are fragmented and necrotic. But it is in the hepatic cells themselves that the process reaches its height. The yellowish and yellowish white areas mentioned correspond to areas of coagulation necrosis, of which several varieties have been described.[1] Such foci are often surrounded by large quantities of nuclear detritus probably swept thither in the lymph current.

In chronic cases from intestinal indigestion degenerative changes of a much slower character than these and a correlative proliferation of connective tissue, replacing the necrotic elements can be seen. Such a process has been observed in the kidneys, muscles, spleen, lymph glands, central nervous system, intestines, and more especially the liver, where cell necrosis is always most profound. There is nothing peculiar or distinctive in the location of such fibrosis nor in the manner of its occurrence.

Symptoms and Physical Signs.—Three classes of the acute form may be recognized—(1) mild, (2) severe, and (3) toxic.

(1) In cases of the *first* class there is a sense of abdominal uneasiness or, much more frequently, paroxysmal griping pains, referred to the umbilical region. Some tenderness may exist in this region; the pain may be relieved by pressure. Vomiting, due either to immediate gastric irritation or to reflex stimulation is comparatively rare. Diarrhœa

[1] Flexner: "Pathologic Action of Certain So-called Albumins," *Med. News*, Aug., 1894, p. 116.

is of almost invariable occurrence at some period of the attack. In the majority of cases the abdomen is distended and highly tympanitic; in others it is retracted, rigid, and knotty from the irregular contraction of its muscular walls. Boborygmi accompany abdominal distention. While the pains last, if they are intense, the countenance has an anxious, frightened expression as in colic, the pulse is depressed, the respirations are shallow, and the skin is cold. The tongue is usually coated and the head aches. In this form fever is slight or absent. The mildest attacks may cause only a feeling of abdominal distress, tympanites, boborygmi, and slight diarrhœa.

(2) The great majority of cases fall under the *second* class, where the symptoms are less uniform. The onset may be gradual, after several days of listlessness and impared vitality, or more frequently it is sudden and abrupt. The local symptoms are much the same as in the former class. Pain is paroxysmal and griping, or heavy, dull, and felt only at some definite point. Usually it begins near the umbilicus and thence shifts to various parts of the abdomen; "it does not intermit as in colic, but exacerbates and then changes to a dull feeling of distress." Pressure increases it greatly, and the patient lies on his back as in peritonitis with the legs flexed to relieve the tension of the abdominal muscles. Tympanites, flatulence, and borborygmi indicate the formation of gas. Succussion sounds may be elicited.

Diarrhœa succeeds this active onset; the stools vary in number from two to twenty in twenty-four hours. At first they are soft, of normal fecal odor, and either brown or yellow; later they become thin, watery, and frothy, and when the bile has been drained away are grayish. The odor is then putrid, sour, cadaveric, or musty; later the stools may be odorless. Mucus and particles of undigested food, especially proteids, are present in variable amounts. The reaction is neutral or alkaline, less frequently acid, and is determined as much by the character of the food as by bacteriological activities. Microscopically are seen epithelial cells, round cells, occasional blood cells, bacteria (chiefly the varieties already mentioned) Charcot's crystals, crystals of oxalate of calcium, calcium phosphate, ammonio-magnesium phosphate, cholesterin, and fatty acids. Pus is seldom present.

Usually there is vomiting at the outset; this quickly subsides, and it may not occur at all during the entire course of the disease. The tongue at first is moist, covered with a thin white fur, later it is red, dry, and glazed. In children it is "raw." The breath is always offensive. There is pronounced thirst, but no desire for food. In children aphthous stomatitis may develop.

The general symptoms are well marked. In the majority of cases there is a sharp chill, and when the attack is established fever runs high—103° to 104° F. In some rare cases in children the evening temperature may be 105°, falling to normal during the night, to rise to a considerable height again during the ensuing day. At the outset the pulse is full, tense, and bounding; later it is small, tense, and wiry. The skin is hot and dry, but profuse sweating occurs at night. Cramps in the lower extremities, especially in the calves and in the feet, may be a most distressing symptom. Convulsions are frequent in children. Headache is one of the most common symptoms, persisting long after

the acuteness of the attack is past. For several days after disappearance of the fever the patient is dull and apathetic.

(3) In the *third* class of cases the symptoms are those of an obscure but violent toxæmia. The onset is sudden, with intense vomiting, at first of mucus, later of coffee-ground material. This vomiting is the most noticeable symptom, sometimes the only one. Occasionally there is slight icterus, but in no case is this well marked. In rare fatal cases the temperature is subnormal, coma rapidly supervenes, and the patient dies in collapse.

Allied to this toxic type, and in many respects analogous with it, is cholera infantum. In the vast majority of cases this is due to intestinal indigestion and consequent auto-intoxication. The particular symptoms which it offers are possibly caused by those conditions of digestion peculiar to children, and the correlative actions of several micro-organisms or classes of these. It is also probable that the profound general symptoms in the algid stage of *cholera nostras* are due, in part at least, to the absorbed toxic products of indigestion, while the local symptoms in the vast majority of cases are caused by the direct action of all those irritants resulting from intestinal putrefaction and fermentation.

Chronic Indigestion.—The larger part of those cases of chronic gastric indigestion which apply for treatment are necessarily complicated by more or less intestinal disturbance, but the profession has yet to learn that in the greater number of the indigestions the latter condition is of major importance. Chronic intestinal indigestion has never received the attention that it deserves; it is seldom even mentioned in standard works on the practice of medicine. Yet cases of the disease are of such frequent occurrence that they should be recognized and discussed under a separate caption.

One of the most invariable symptoms is flatulence, coming on from one and a half to three hours after meals. It is due chiefly to fermentative processes, and is therefore worse after the ingestion of carbohydrates. Coincident with it are a sense of distention and heaviness, tenderness, and perhaps vague abdominal pains, especially in the right hypochondrium. Acute pain is comparatively rare. The greatest distention may occur near the umbilicus, or it may be evenly diffused and general. Constipation is the rule in adults, and the stools, hard and dry, are expelled with difficulty. Sometimes they are coated with shreds of mucus. Diarrhœa may alternate with constipation, or if there be much enteric catarrh the diarrhœa may be constant. The passage of unaltered food, as fragments of meats, vegetables, or fruits, indicates the nature and extent of the lesion. Sometimes there are short intercurrent symptoms, evidenced chiefly by an aching sensation in the right hypochondrium, jaundice, and the passage of colorless stools. The appetite may not be much impaired, but it is fitful and irregular. There is invariably a bad taste in the mouth, the breath is offensive, and the tongue is large, pale, and coated.

The general symptoms are in part due to auto-intoxication, but often they, with the intestinal trouble itself, are the manifestations of a primary central nervous disturbance—neurasthenia. There is no doubt, however, that in this latter case they are aggravated by the coexistent intestinal indigestion.

The general nutrition suffers; the skin is hard and dry, pale, or of a sodden, muddy hue. In advanced cases it is icteroid or bronzed. Erythema, urticaria, acne, eczema, psoriasis, and many allied conditions occur with such frequency in the course of this disease that it is by some authorities considered their most usual cause. Polymyositis is usually observed. The bones may become the seat of nodosities and the synovial membranes of the small joints especially are liable to inflammation and subsequent infiltration.

The action of the heart is disturbed, partly from mechanical but mostly from nervous influences. There may be tachycardia, bradycardia, arrhythmia cordis, debilitas cordis, etc. It is not rare to find one or more of the cardiac sounds somewhat altered. The general circulation is languid and irregular; cold hands and feet and cold sweats urgently testify to the former, and irregularity or suppression of the menses to the latter condition. The temperature may be increased; more frequently, however, it is normal. Dyspnœa, Cheyne-Stokes, or stertorous breathing indicates implication of the respiratory centres. The expired air may have an odor of hydrogen sulphide, acetone, or ammonia.

The symptoms presented by the special senses correspond to those in other chronic intoxications. Autophony, tinnitus aurium, deafness, muscæ volitantes, hemiopia, diplopia, and many perversions of taste and smell have been observed.

Of the symptoms more immediately referable to the nervous system, headache is the most constant and persistent. It may be occipital, frontal, diffuse, or felt only as a constricting band about the head. There are other symptoms found in connection with intestinal indigestion which are due to an associated neurasthenia. These are wrongly regarded as caused by the indigestion, and therapeutic measures based upon this view invariably fail of success. Such symptoms are vertigo, syncope, collapse, partial or general convulsive seizures of variable duration, paralyses, fugacious painful contractions of certain muscle groups, angeio-neurotic œdema, protean sensory disturbances, restlessness or apathy, insomnia, and waking in the early hours of the morning with cardiac palpitation. Lassitude, general debility, incapacity for any protracted mental or physical work, hypochondriasis, melancholia, and irritability of temper are also common.

Whether neurasthenia or indigestion be of prior occurrence, each has a retroactive effect upon the other, and it is noticeable that those cases of neurasthenia in which digestive disturbances are prominent will usually run a most severe course. That this is due to faulty elaboration and assimilation of food is evident, but just how far purely toxic products are a factor is indeterminable. It is altogether probable that their influence has been overestimated.

The urinary changes common to both acute and chronic intestinal indigestion are important. The total amount of fluid is reduced, it is high colored, and the specific gravity is slightly increased. The presence of acetone, diacetic acid, and sulphuric ether has often been established. An increase in the amount of the ethereal sulphates, especially indican, invariably occurs in all cases of intestinal putrefaction, if peristalsis does not quickly empty the bowel. It is therefore most evident in cases of chronic indigestion. Traces of albumin are

often present. Uric acid, the urates, and urea are excreted in absolutely less but relatively larger amounts. There are usually crystalline deposits of uric acid and calcium oxalate.

The relation of diseases of the skin to defective duodenal digestion is not admitted by most dermatologists to be that of effect and cause, but that they are coincident, especially in childhood, is undoubted, and that the cure of the intestinal defect is followed by improvement in the condition of the skin is equally certain.

Complications and Sequelæ.—Gout and lithæmia are definitely traceable to intestinal indigestion. The increased activity of both liver and kidneys, necessary to meet the prolonged absorption of imperfectly digested foods and toxic materials, is such that the way is readily paved for chronic disease of either or both of these viscera. Many cases of hepatic cirrhosis and chronic interstitial nephritis are the ultimate lesions in long-standing cases of this form of indigestion.

Appendicitis is probably often the final stage in intestinal indigestion which leads to catarrh of the cæcum, and consequent multiplication of bacteria with infection of the local peritoneum.

Diagnosis.—*Acute Forms.*—A diagnosis must be made from gastric dyspepsia, gastralgia, enteralgia, ulcer of the duodenum, perforation, intestinal obstruction, biliary colic, hepatalgia, appendicitis, nephralgia, and neuralgia of the dorsal and lumbar nerves.

Gastric dyspepsia is attended by pain in the epigastrium immediately after eating, vomiting is frequent, and the vomitus consists of food that is either unaltered or in a state of acid fermentation. There is eructation of gases. The intestinal symptoms are not prominent.

In gastralgia and enteralgia the patient is anæmic, neurotic, or neurasthenic, and the attack does not necessarily have any relation to the ingestion of food. There is no tympanites, no fever nor diarrhœa. Pressure relieves the pain, and increase of meat diet and tonic treatment cure the disease.

In ulcer of the duodenum the seat and time of pain are the same as in duodenal indigestion, but the intensity of suffering is out of all proportion to the phenomena of simple indigestion. Sooner or later in most cases a diagnosis is made clear by the vomiting of blood or more frequently by melæna.

In perforation there is a suspicious history of ulcer or cancer, and the facies, prostration, and collapse indicate that the disease is far more profound than in simple indigestion. If the patient live long enough the pain is accompanied by great distention and extreme tenderness. Alonzo Clark's sign—obliteration of hepatic dulness from the presence of air in the peritoneal cavity—is of extreme value in doubtful cases.

Intestinal obstruction is accompanied by persistent vomiting often becoming fecal, obstinate constipation, and great prostration. Fever is present or the temperature is subnormal. An examination should be made at those points where herniæ are of most frequent occurrence, and the abdomen palpated and percussed in an attempt to establish the presence or absence of fecal accumulations or the sausage-shaped tumor of intussusception.

Biliary colic is known by intense and sudden pain in the epigastric region and by severe nausea and vomiting; it often ends suddenly and

there is ensuing jaundice; there is probably a history of former attacks, and gall-stones may be found in the fæces.

Hepatic neuralgia (the existence of which is denied) is said to present the symptoms of biliary colic, to recur after more or less definite intervals, and to be accompanied by great tenderness over the liver and by neurotic symptoms. None of these occur in intestinal indigestion.

The pain of the onset of appendicitis is occasionally noted in the epigastrium. The accompanying tenderness and flatulent distention might create a suspicion of acute duodenal indigestion. But in appendicitis the excessive tenderness on pressure over McBurney's area, the general tympanites, the more pronounced constipation, the flexion of the right thigh and the higher fever serve to localize the disease in the appendix.

The pain in nephritic colic is paroxysmal, with intervals of comparative ease, and is unassociated with fever. It comes on suddenly, is most intense and is felt usually in the loin, shooting along the ureter to the bladder. The localization of the pain is not constant, however, and since it may occur in the umbilical region, where the pains of intestinal indigestion are usually felt, its value must not be over-estimated. The most valuable diagnostic symptoms are vesical tenesmus, strangury, the frequent passage of small quantities of high-colored or bloody urine loaded with uric-acid crystals, the numbness of the corresponding thigh, and retraction of the testicle.

The dorsal and lumbar nerves are subject to neuralgic affections which exhibit paroxysms of pain unaccompanied by fever. When this condition occurs in those nerves supplying the abdominal parietes, a diagnostic sign of the greatest importance is its unilateral distribution and the presence of hyperæsthetic areas. Neuralgia of the intestinal or mesenteric plexi is differentiated by the absence of diarrhœa and tympanites, its frequent recurrence, and the sense of extreme prostration which attends it. A history of malaria is often obtainable. The most reliable sign from a purely diagnostic standpoint is its ready amelioration by antineuralgic treatment.

Cases of intestinal indigestion that are moderately severe are usually easier of diagnosis than are those of either the mild or toxic type. A differentiation from catarrhs of various parts of the alimentary tract is the most difficult. Practically in all acute indigestion there is more or less catarrh, and *vice versâ*, though in catarrh of the lower part of the ileum and the colon there may not be that degree of indigestion which the frequency of the stools may appear to indicate. Hard and fast lines cannot be drawn. The absence of indican or other increased ethereal sulphates from the urine, the presence of mucus in large amounts, not intimately mixed with the other ingredients of the stool, the absence or a very slight degree of lientery, and the presence of bile in proximately normal amounts, are indications that the condition is one of colitis. When, however, the stools are thin and fluid, containing mucus intimately mixed with homogeneous fluid fecal matter stained with bile, and when there is decided lientery, the catarrh is duodenal and is complicated with indigestion. Which was of prior occurrence and is the real disease is determinable only from the history.

Fortunately, in such conditions the indigestion is usually cured by curing the catarrh.

In those cases coming on with a chill, high fever, tympanites, and the passage of numerous fluid stools, a diagnosis depends in great part on the history and is often reached with difficulty. In many respects it may be so similar to several infectious diseases, especially those which follow an anomalous course and in which intestinal symptoms preponderate, that a decision may be impossible until the case has been watched for several days. In children the disease may simulate those cases of scarlatina in which the lesion involves the intestine rather than the skin. A diagnosis would here be based on the temperature chart, a history of exposure, the marked prostration, and the tendency to collapse.

Typhoid fever, especially in a child, is often mistaken for gastro-intestinal indigestion. In the latter the temperature rises more sharply, the remissions are slighter (there may be intermissions), and the final drop is more sudden. As a rule, a continued fever which lasts a week without any definite local cause is enteric fever.

The intermissions which are sometimes seen in the fever, the night-sweats, diarrhœa, tympanites, etc., occasionally suggest acute tuberculosis. The history and cause of the disease will clear up this diagnosis.

In diarrhœa due to purely nervous influences the stools are passed independently of the ingestion of food, and there are no objective signs of intestinal indigestion. Usually there has been a nervous crisis and the patient is neurotic.

Those cases which conform to the toxic type can be diagnosed only by the exclusion of acute mineral poisoning, peritonitis, hemorrhagic pancreatitis, and acute intestinal obstruction. The nature of the vomitus excludes the first. The second is excluded by the absence of any suspicious history, the superficial respirations, and the usually slower course of the symptoms. Hemorrhagic pancreatitis and the cases of intestinal obstruction which run the most rapid course are accompanied by more violent pains, and the ethereal sulphates are absent from the urine. In only one of eight cases of which the notes are at hand was a diagnosis made, and it was then based more upon the history of ingestion of food which was tainted than upon the immediate symptoms.

Chronic Form.—Attention must be given to the mode of life, hours and manner of eating, kinds of food, and general habits of the patient. In chronic gastritis there is invariably some intestinal disturbance, so that it cannot be clearly differentiated. Chronic intestinal indigestion may, however, obviously occur without gastric indigestion. In this case the pain (if there be any), or at least the feeling of heaviness or distention, is not localized in the epigastrium and there are no eructations of gases and acid fluid and no vomiting. The loss of flesh from gastric is much less than from intestinal disease, and hypochondriasis, irritability, and other mental symptoms are not so evident.

In cases of intestinal cancer or cancer of the mesentery there is more rapid wasting than in intestinal indigestion; possibly a tumor is palpable, there may be melæna, the pain is more severe and is localized more sharply, and an examination of the blood reveals the characteristics incident to carcinomatous disease.

A diagnosis of the differences in digestion due to defects in specific ingredients of the pancreatic or intestinal secretions is not yet a matter of precise knowledge. A poor digestion of the carbohydrates, with which the intestinal juice and amylopsin have especially to deal, is indicated by constipation, flatulence, and tympanites; a poor digestion of the proteids by a greatly increased amount of the ethereal sulphates, especially indican in the urine, some tympanites, and more pronounced general symptoms; and a poor digestion of fats by their appearance in the stools.

Intestinal neuroses are not accompanied by emaciation; the patient has a strong, healthy appearance though a diarrhœa may have existed for years. A diarrhœa upon which diet has no influence begins generally at the hour for normal defecation or immediately after eating. For a time the stools are frequent and they then cease for a longer period.

The general neurotic symptoms which so often accompany intestinal indigestion are now regarded as often being with it the manifestations of a primary disease of the nervous system. A diagnosis of either neurasthenia or intestinal indigestion is reached, according to the preponderance of local or general symptoms, the history of the case, and the response to different lines of treatment. Usually the one condition will complicate the other if it last long enough. A history of nervous symptoms before the intestinal disease began, or a greater intensity of these than could be well attributed to it alone, are the most valuable indications that the indigestion is merely a symptom.

Prognosis.—In the acute cases of the mild and usually in those of the severe type the prognosis is favorable, depending altogether upon the intensity of the symptoms. In the purely toxic cases it is almost invariably fatal.

Of chronic cases it may be said that, if treated early and energetically, cure may be expected. Death from the immediate intestinal disease occurs only in the toxic cases, but may follow the renal and hepatic complications and sequelæ. Discouraging symptoms are anæmia, debility, coexisting gastric dyspepsia, emaciation, and hypochondriasis. In strumous children the prognosis is less favorable.

Since everything hinges upon the extent to which the patient submits to the strict directions of his physician, his whole life must be made subordinate to the plan of treatment; and upon this the prognosis depends.

In organic disease of the pancreas, intestine, or liver the prognosis varies with the nature and curability of the lesion.

Treatment.—As acute cases occur most frequently in children of from eight to eighteen months of age, during which period weaning, dentition, and the danger from summer heat occur, the child should be sent to the country for the whole of the heated season; or if it remain in the city should be protected from the effects of heat as far as possible; wherever it may be, great attention should be paid to the selection of a diet suited to the age and individual peculiarities.

A most important part of the treatment of the attack is the management of the diet. For the first twelve or even twenty-four hours all food should be withheld, but small quantities of boiled water, of

rice or barley water, may be given every hour, to compensate for the fluid lost in the stools. Breast-fed infants must not nurse until vomiting has stopped, and when the feedings are resumed they should be brief, and the intervals between them long. For hand-fed infants, until all acute symptoms have subsided dependence should be placed rather upon animal broths and juices, in small quantities, than upon cow's milk. This may then be resumed, largely diluted or peptonized, and the return to the former diet must be gradual. Albumen water, made by mixing the uncooked white of an egg with half a pint of sterilized water, is often retained when milk is rejected. For adults the preparation may be made more palatable by the addition of ice, the juice of half a lemon, and a small quantity of sugar. The diet must be fluid for several days after all acute symptoms have subsided, and the first semisolid aliment should consist of such readily digested food as gelatin, cetraria, soft-boiled eggs, etc. Inasmuch as regulation of the diet is the most important part of the treatment of these cases, the physician must be specific and definite, leaving nothing to the caprice of the patient, and he must see that his orders are obeyed.

In the adult cases no medicinal treatment may be demanded in the largest number of cases; absolute rest and diet will be all that is needed. Intense pain may require opium in some; morphine hypodermatically for adults is to be preferred, with mustard poultices to the abdomen. Tympanitic distention is relieved by turpentine stupes and by a large rectal injection of hot water.

Since acute intestinal indigestion implies the presence of fermentative decomposition and irritating substances in the intestine, the diarrhœa that accompanies it is immediately beneficial, and should not be checked until all such irritants be passed. It is only when pain is great and the stools very frequent that it should be even controlled. It usually occurs soon after the symptoms begin to develop, but in most cases is followed by a diarrhœa which is indicative rather of catarrhal inflammation than of the primary indigestion itself. As this catarrh is necessarily in its turn the cause of subsequent indigestion its medicinal treatment must be discussed here.

The treatment usually begins with the administration of calomel, castor oil, magnesium sulphate, or aromatic syrup of rhubarb, in order to remove any irritating substance which in spite of the diarrhœa may remain in the bowel. One of these drugs is given when the patient is seen first. Magnesium sulphate is of very recent popularity in this disease and its comparative claims have not yet been established, though it has given many excellent results. This is probably because it occasions free osmosis of serum without increasing the blood supply, and thus lessens the degree of congestion. Castor oil should be given in emulsion. Calomel in small repeated doses, combined with sodium bicarbonate, is perhaps the best laxative for children and infants.

Attention must be given to the stomach in order to prevent the passage into the intestine of undigested food and the products of gastric putrefaction. The viscus will empty itself in some cases; if it does not, an emetic or lavage is needed.

About six hours after the administration of the purgative some of the remedies for diarrhœa or the so-called intestinal antiseptics may be

given. Salol, gr. i–v, with bismuth subnitrate gr. v–x, every two to four hours, is a favorite combination. The possibility of doing good by antiseptic medication is not admitted by all. Albers, who is usually regarded as the best authority upon the subject, states that while many bacteria in the intestinal contents are readily passed in the stools, others remain behind in the intestinal glands and follicles, where, being protected by a film of mucus, they cannot be reached by antiseptic drugs. Yet these are the bacteria which are the first to give up for absorption their chemical products and which it is the most desirable to destroy.

Many germicides which act in test tubes are worthless as remedies in the intestine unless, as Ewald states of all of the remedies of this class, they be given in doses sufficient to fill the intestine, in which case they would be toxic to the organism. Calomel has long held a most enviable reputation, but its efficacy is not shown to depend entirely upon its purgative properties. Fecal retention is the condition that leads to bacterial multiplication and albuminoid and carbohydrate decomposition; Pfunger has shown that a medicine has an influence upon these processes directly in the proportion in which it is efficient as a purgative.

Though this view with regard to the more distinctly pathogenic organisms, as *B. typhi abdominalis*, is now well established, the majority of the profession still adhere to the belief that in indigestion and catarrhal states, when the micro-organisms are of less irritant type, antiseptics are efficacious. It is possible that in such cases the divergent results may be reconciled on the assumption that the insoluble agents prevent the further migration of such germs into the intestinal wall, while those already there are disposed of by phagocytosis, and that the soluble agents while in process of absorption exercise their function upon those already in the tissues. Drugs of this class are ineffective unless given in large doses. Insoluble antiseptics are calomel, bismuth subnitrate, bismuth salicylate, menthol, naphthalin, cresol, paracresol, thymol, creasote, and ichthyol. Soluble remedies comprise carbolic acid, salicylic acid and its salts, tannic acid, resorcin, silver nitrate, saccharin, mercuric chloride, potassium permanganate, and hydrochloric acid. Salol, benzonaphthol, and cresalol are synthetic preparations that are decomposed in the upper part of the intestine, the first into carbolic and salicylic acids, the second into benzoic acid and naphthol, and the third into salicylic acid and cresol. Nosophen or its bismuth salt, eudoxin, in from five- to eight-grain doses, and the oils of cloves and cinnamon in drop doses, have recently been used with reputed success.

Fel bovis would supposedly be the ideal antiseptic, but is utterly inert unless conditions are such that bile acids may be set free, and such conditions seldom exist in the diseases in which it is given. Those intestinal antiseptics that are decomposed in the stomach because of its acid reaction are very likely to be decomposed in the intestine also, for in indigestion, because of the acetic, butyric, propionic, and other acids elaborated, the normal acid reaction of the contents of the upper bowel is much intensified. Keratin is a much better protective from the action of the gastric juice than are other substances, and is more likely to be dissolved in the intestine. Often, however, such solution does not occur.

In those cases where there is not much inflammation, arsenite of copper, in gr. $\frac{1}{100}$ doses every three hours, has been advised. Its mode of action and its exact value have not been definitely determined. If it does no good in thirty-six hours, its use should be stopped. Astringent drugs, some of which are at the same time antiseptic, are tannin, alum, cotoin, paracotoin, tannigen, bismuth subnitrate, and bismuth subgallate.

To further accomplish intestinal disinfection rectal irrigations with soluble drugs are employed, and are frequently of the greatest service. They act directly, and the mechanical influence of the water used renders them far more efficacious than are drugs given with the same object by the mouth.

The solutions used and the amount per pint are: silver nitrate, gr. iij–v; potassium chloride, ʒj; tannin, ʒss–j; iron sesquichloride, gr. xv; boric acid, ʒij; creolin, gr. viij; salicylic acid, gr. xv; quinine hydrochlorate, gr. viij.

If cold water be used with these enemata, they are mild and grateful antipyretics; whether the water be cold or warm, they prove as serviceable as any means we have in emptying the lower bowel of fæces and bacteria, arresting peristalsis, and favoring the expulsion of gas.

Chronic Forms.—As in acute, so in chronic cases of intestinal indigestion, prophylaxis is of noteworthy importance. The necessity of perfect mastication, insalivation, and gastric digestion have already been emphasized in the section on etiology, but it may be well to repeat that no good results can be expected until these processes are normal. Attention to faulty teeth, or habits that waste or weaken the saliva, as smoking or chewing, is often the first step toward a cure.

Much of the treatment is hygienic and dietetic. In the great majority of cases perhaps the greatest benefit is derived from a change of climate and scene, and in not a few this has proved the only means of accomplishing a cure. A sojourn at the mineral springs is especially advantageous, for here there is not only another environment, but bathing and the use of drinking-water are indulged in to a much greater extent than under other circumstances. The importance of systematic baths has long been appreciated in Europe, and it is to be regretted that hydrotherapy is not more available nor made use of more generally in this country. Much of the improvement that ensues after a summer spent at the seashore is traceable to the daily plunge in the surf. Evenéef has demonstrated the great utility of cool bathing in all cases where the absorption of fats is deranged, and pertinently insists upon the use of sponge baths. In a fair proportion of cases daily application of the cold douche to the back or abdomen, the cold pack to the abdomen, or in selected cases a general hot bath, will prove a convenient means of inducing a revolution in digestive activities.

The mineral waters so much used by dyspeptics are of utility by inducing the patient to drink water freely. They are especially serviceable in cases where there is hyperacidity of the gastric juice, obstinate constipation, or a gouty diathesis.

The waters most serviceable in this connection are those of Vichy, Ems, Kissingen, Homburg, Wiesbaden, and Saratoga.

The benefit derived from a course at Aix, Vichy, or Carlsbad is in

great part due to the leisure, enforced diet, and entire change of surroundings that result from a European trip. Many confirmed cases of indigestion, especially those following overwork and worry, are quickly benefited by the regimen of a foreign cure. At home, fresh air, moderate exercise, diversion, and relaxation are of great help.

The routine advice as to exercise is often productive of great harm; these patients are so often suffering from neurasthenia that it is rest rather than exercise which is needed. Where neurasthenia is the chief pathological condition a rest cure, total or modified, is a necessary preliminary to treatment.

For very feeble persons, and especially for women and sufferers from neurasthenia, massage should take the place of exercise. The Swedish movement cure has been much over-estimated and abused, but in suitable cases it will expand the thorax and abdomen, hasten the circulation and quicken all the functions of nutrition and secretion.

The rules for diet should be emphatically impressed upon the patient. At the commencement of the treatment an exclusive milk diet continued for one or two weeks will shorten the duration of treatment. Skimmed milk is sometimes of service as a continuous diet, as larger quantities of it may be taken without distaste or a sense of repletion. In this connection it is interesting to note that Gilbert and Domenici have recently discovered that an exclusive milk diet influences in a remarkable degree the number of micro-organisms in the alimentary canal. In experiments upon men they found that the number of these organisms was reduced from 67,000 to 25,000 per gramme, and the weight of the fæces passed had fallen from 175 to 73 grammes. Sterilized milk has no greater effect than ordinary milk.

Inasmuch, however, as patients will not tolerate this diet long, recourse must be had occasionally to koumyss, meat extracts and broths, albumen water, barley water, etc.

A change to solid food should be made gradually. Proteids should be allowed before fats and carbohydrates. Sweetbreads cooked in milk are well suited for a beginning; raw oysters, fish, especially the varieties that contain very little fat, are easy of digestion. Poultry, finely minced, may then be eaten, and after this rare beef and mutton may be added to the diet. When bread is given, it should be light and porous, dry and browned in the oven. Toast disagrees with some. Light biscuits and crackers are often better digested than bread. Vegetables can be given later in small quantities and when the patient is convalescent. Lettuce, kale, spinach, and celery contain less starch than do others and are therefore less objectionable. Fruits, as oranges, pears, or grapes, if they are digested after trial, prove beneficial.

Instead of the light breakfast and late heavy dinners, early breakfast, midday dinner, and light tea are to be preferred. The patient must avoid excess in eating.

Fatty, saccharine, and farinaceous foods, sauces, condiments, and all indigestible articles, are to be forbidden. The too free drinking of water, especially of ice water, at meals, impedes digestion. Carbonated waters, especially Apollinaris water, are less objectionable; wines and beer are as a rule to be condemned, but dry champagne, for those who like it, is the best form of stimulant. In some cases whiskey, well

diluted, given at meal time, does well for those accustomed to the use of stimulants. Good Scotch whiskey is often to be preferred.

The bowels must be kept open, by the cultivation of regular habits or by small cool water enemata. Sodium sulphate, calomel, podophyllin, or the laxative mineral waters may be required. In children, since diarrhœa instead of constipation is the rule, there is not so much need for purgation, but an occasional dose of calomel or castor oil will ensure the removal of any irritating substance and thus be of service.

Many patients, especially children, will need a general tonic. Perhaps the most serviceable preparations are the carbonate, lactate, or pyrophosphate of iron. The syrup of the iodide of iron, quinine, strychnine, and hydrochloric acid in combination may prove beneficial. The bitter tonics should not be given, except for loss of appetite, and in those cases only where there is no gastric disturbance.

INTESTINAL SENSORY NEUROSES.

Enteralgia; Colic; Enterodynia; Hyperæsthesia or Neurasthenia intestinalis; Neuralgia mesenterica; Anæsthesia intestinalis.

The intestines may be the seat of various sensory neuroses, either as an accompaniment to various diseases or as original nervous disturbances.

The principal type of this disorder to be considered is that form known as—

Colic, Enteralgia, or Enterodynia.—This is chiefly a neuralgia of the mesenteric nerve fibres, and may or may not be accompanied by a spasmodic contraction of the muscular coat of the intestine. It has been likened to such unstriped muscular spasm as occurs in uterine, biliary, or nephritic colic. The spasm, though, may occur alone without causing pain, under which circumstances it would be difficult to recognize it.

Pathology.—Pathologically, the condition is a sharp, short muscular tetanus involving chiefly a portion of the intestine, and followed by an excitement of the intestinal nerves which is manifested by a severe pain termed colic, or a hypersensitiveness to normal irritants. The functional activity of the bowel may be increased as in an active peristalsis, but, taken alone, under these circumstances there may be no pain whatever, as in this case the muscular excitation extends along the whole length of the bowel and is not a limited or localized spasm.

Etiology.—The causes of the increased sensibility of the intestinal nerves may be some unusual or abnormal irritant from within, reflex excitation, or blood changes; there may be an intensification of the normal physiological processes with hyperæsthesia. This latter is a local condition existing in the mesenteric plexus of nerves.

Internal irritants may be food composed of some irritating or indigestible substance; large amounts of food or articles prone to decomposition. Ice water, ice cream, and other cold fluids or solids, especially when the individual is in a heated state, are often the cause of immediate pain. Some change in diet where an individual has been following a uniform regimen acts in the same way. Individual and family idiosyncrasies are known to produce sensory reactions to foods that are

without effect on other individuals. Shellfish, cheese, eggs, and certain fruits are known to act in this way.

All the factors contributing to the origin of an intestinal catarrh may be the cause of colic (*colica catarrhalis* or *inflammatoria*). Here it may be noted that the colic is not due to increased peristalsis, but to some tetanic contraction of some part of the bowel. Peristalsis is a normal process, and its increase, as in diarrhœa, may occur without pain. Usually, when colic accompanies this condition of enteritis, increased peristalsis may follow the colic, or *vice versâ*. This has been known as *colica biliosa* or *colica æstiva*.

Foreign bodies, as gall stones; entozoa; cathartics, as castor oil, colocynth, and senna; scybala or large fecal accumulations undergoing putrefaction,—are frequent causes of colic. *Colica stercoralis* is productive of severe pains. Sometimes acute constipation occurs at intervals of several months, producing attacks similar to the above form.

Associated with this condition may be mentioned gaseous formation due to putrefaction or to substances easy of decomposition, whereby the bowel is abnormally distended, bringing on a spasmodic contraction of the muscles and causing a painful irritation of the nerves (*colica flatulenta*). This is possible in a single portion of a loop of intestine, but a general distention, such as occurs in meteorism, may be without colic and would not be classed with this form.

Another peculiar nervous condition properly classed as a secretory neurosis is the accumulation of large masses of mucus (*colica mucosa*), which is recognized by the passage of mucous casts.

Reflexly, a colic may be caused by taking "cold" as the result of wetting the feet or any part of the body (*colica rheumatica*). Colic may accompany uterine, ovarian, bladder, or kidney disease as a result of reflex irritation, probably through the sympathetic splanchnic nerves.

Certain conditions of the blood, containing toxic substances from absorption (ptomaïnes, etc) or the retention of normally formed excretory products, as urea or uric acid, act by causing irritation of the intestinal nerve-endings, with a consequent hypersensitiveness, as well as an increased activity of the muscular structure.

Many pathological processes may be accompanied by colic, as, for example, appendicitis, probably due to spasm of the muscular wall of that structure; intestinal ulcers, as in the duodenum; strangulated hernia or any incarceration or obstruction of the bowel. Changes produced in the nerves themselves, as in lead or copper poisoning, are spoken of in a separate section elsewhere (see Chronic Metal-poisoning). Enteralgia may be, as already noted, purely a nervous phenomenon without any explanatory cause, except that there exists a general irritability of the sensory nerve fibres so frequently present in hysteria and neurasthemia (*nervous enteralgia* or *colica nervosa*).

Symptoms.—The approach of an attack of colic is not always the same. It is usually of sudden onset, with pain of a pinching, tearing, cutting, or boring character, lasting a few minutes at a time, or it may even last several hours. Remissions and exacerbations of these attacks occur; other reflex symptoms appear, depending upon the degree of acuteness of the condition; the number of periods of pain may vary from one attack to paroxysms lasting for several hours or days.

A moderately severe attack is characterized by a sharp, cutting pain located in the abdomen, particularly in the umbilical region, and spreading out to other regions. There may be other symptoms, as nausea, eructation of gas, and flatulent distention. The pain will disappear abruptly, and may be followed by recurrences. In the intervals the patient may feel perfectly well, as the chief symptom disappears entirely. The face may look pinched, flushed, or pale during the attack, and sweat frequently appears on the forehead after the attack.

In the severe cases the patient is suddenly seized with a griping pain in the abdomen; the hands are placed over the seat of suffering, the knees and thighs are drawn up to the abdomen, or the patient throws himself face downward across a lounge or bed. The pulse may be small, frequent, and intermittent. The spasm of the muscles may extend to the cremasterics, which is shown in a retraction of the testicles; the anal muscles may also be affected, the anus being drawn inward. The bladder may be involved, in consequence of which a drawing, pressing sensation is felt in the bladder and rectum. In extreme cases the thumbs are flexed in the palms of the hands, and other and more general muscular contractions occur. The patient may become unconscious or may show signs of delirium.

On the disappearance of the pain the patient feels exhausted; he assumes a comfortable position only to be disturbed on the return of pain.

In a more severe colic the patient is suddenly stricken with an abdominal pain; the face is pinched and has an agonized look. His feet and hands are cold and a cold perspiration covers the body. The posture of the patient is that of one doubled up, his hands over the seat of pain and thighs flexed on the abdomen, which may be distended and tympanitic; there may be borborygmi, and the expulsion of flatus may bring slight relief. The pulse is small, rapid, and irregular, and collapse may supervene. The abdominal walls may become tense or even drawn inward toward the spinal column, the muscles being entirely rigid and hard, or there may be marked distention, knuckles of the bowel standing out in relief.

Reflex symptoms, as palpitation, dyspnœa, syncope, strangury, and general convulsions, may occur.

The appearance of large masses of mucus in the stools has led to the description of the form of enteralgia termed *colica mucosa*. According to Nothnagel, DaCosta, Woodward, and others, this is chiefly a nervous phenomenon occurring in neurotic individuals who suffer from habitual constipation; they are subject to sudden colicky pains radiating over the abdomen from the left abdominal region along the line of the descending colon. This is followed by the passage of large membranous masses of mucus. The attacks are of variable frequency. Van Swieten attributes the condition to some disturbance in the biliary secretion, because of the fact that the stools after the passage of the mucus are poor in bile. Potain thinks these alterate with liver colic, and therefore associates the two.

Mesenteric neuralgia and nervous enteralgia appear with sudden sharp pains, simulating any colic above described, but are accompanied more frequently by pains in other regions and hyperæsthesia of the skin.

In the hysterical patient other sensory, motor, and sympathetic phenomena occur in which there is an exaltation of the functional activity of the nerves of the abdominal organs.

Intestinal Anæsthesia.—Another form of intestinal neurosis is an anæsthesia of the bowel. No attempt could here be made to describe the symptomatology of this affection involving the upper portions of the canal. The condition is met with in cases of spinal disease and senility, and may be a derangement of sensibility, as found in some hysteric cases. The chief symptom is constipation. If the rectum is involved, the passage of a stool is involuntary and is recognized by the patient from the odor alone. A chronic constipation may ensue, and a serious condition, as ulceration or rupture of the bowel, may follow.

Diagnosis.—Some difficulty may arise in the distinguishing of enteralgia from some inflammatory process, as enteritis or peritonitis. We may even have enteritis as a cause of the colic, but the occurrence of diarrhœal stools and fever, with the history of the ingestion of improper food, etc., may serve as a distinction between the two. Where enteritis is chronic a point of value is that in this condition there is tenderness along the line of the colon, and food may have some influence in the production of pain, whereas in enteralgia the pains are often independent of food, the appetite is good, and there is local tenderness.

In peritonitis we have fever, vomiting, great distention, and excessive sensibility to touch and movement sufficient to differentiate it from enteralgia, with the knowledge of causes likely to lead to peritonitis.

Where other pathological processes exist a physical examination and a previous history would aid in the diagnosis of ulcers, intestinal obstructions, tumors, cancer, etc.

The pain occurring in rheumatism of the abdominal muscles is increased on any movement of the body, and a soreness exists on pressure; other muscles are frequently involved.

In hyperæsthesia of the abdominal wall we have great superficial tenderness, and when a fold of skin is taken up and the crest of it is slightly pinched great pain is elicited. It occurs frequently in hysterical individuals, so that both a nervous enteralgia and skin hyperæsthesia may exist together; pain then exists both on slight touch and on deep pressure.

In gastralgia, in biliary, renal, and uterine colic, the pain is localized over the area of the organ affected.

Whenever the cause is ascertainable no difficulty is met in the diagnosis of colics due to flatulent indigestion, fecal accumulation, chronic lead-poisoning, the rheumatic or gouty diathesis, or entozoa.

The exclusion of all local causes and pathological processes in a case of colic, and the coincidence of characteristic nervous phenomena, make the differentiation of hysterical or neurasthenic cases a comparatively easy task. They are known by pains occurring at frequent intervals, and sometimes of nearly continuous character, lasting longer than ordinary colics. They are frequently mistaken for other forms of colic, and, as they require treatment quite different from that appropriate to the latter, it is most important to recognize the general causative condition.

Prognosis.—The attack usually lasts but a moment, the paroxysms continuing until the cause is removed. This is rarely more than twenty-four hours. Sometimes one attack or paroxysm occurs which may last from a few minutes to an hour.

Rarely does death occur in enteralgia unless it is followed by rupture of the bowels from excessive gaseous distention (Oppolzer), or from convulsions, as occurred in a child from obstruction by worms (Wertheimber).

The duration of the disease depends upon the cause. The neurasthenic form is the most persistent.

Treatment.—For simple enteralgia relief is quickly obtained by the use of morphine given hypodermically, or opium in some form by the mouth or rectum. A hot bath, or hot fomentations applied to the abdomen, are often grateful.

Constipation, so common a symptom in enteralgia, is best relieved by an enema. The same should be given where there are flatulency and gaseous formation.

When due to "cold" (*C. rheumatica*) the use of opiates and heat applied about the body, with free diaphoresis, may be sufficient. Phenacetin and salol or salicylate of soda may be given with advantage for several days. When due to hysteria, care in diet and antispasmodics, as the bromides and valerian, change of climate, hydrotherapy, moderate exercise, massage and electricity, and the continued use of arsenic have been very successful remedies.

If pathological or inflammatory processes exist, the treatment should be directed to the disease as indicated in each case.

Rectal injections daily, for constipation in cases of anæsthesia of the lower bowel, should be ordered; if overlooked, mechanical means for removing the hard, stone-like masses must be resorted to.

The form attended with mucous discharges must be treated by measures directed to the nervous system and to the digestion.

DISEASES OF THE INTESTINES (Continued).

By HENRY M. LYMAN, M. D.

ACUTE INTESTINAL CATARRH.

Synonyms.—Acute inflammation of the intestines; Enteritis catarrhalis acuta; Catarrhus intestinalis acutus; Enteritis; Muco-enteritis; Entero-colitis; Acuter darmkatarrh; Entérite.

Definition.—Acute intestinal catarrh is an acute inflammation of the intestinal mucous membrane. This may become chronic, and even though it be circumscribed at the outset it may extend to the whole intestinal mucous tract. It is sometimes a local manifestation of an inflammatory process involving nearly if not quite all the mucous surfaces of the body.

Etiology.—Acute intestinal catarrh frequently exists as an original uncomplicated disease, but it is also often encountered as a disorder that is secondary to some other malady. As examples of the former variety may be mentioned those cases of intestinal inflammation that are produced by errors of diet. The ingestion of an inordinate quantity of coarse and imperfectly masticated food is always followed by inflammation of the gastro-intestinal tract, termed *gastritis* in the stomach and *enteritis* in the bowels. Such inflammation, though acute, is usually confined to the mucous membrane, constituting a gastro-intestinal catarrh.

In many instances it is not so much the quantity as the quality of the food that must be incriminated. Unripe fruit, half-grown and badly cooked vegetables, are often causative of catarrhal inflammation of the bowels, with consequent diarrhœa, during the summer months. Tainted meat, fish, milk, ice cream, custards, etc. that have been spoiled by parasitic fungi often excite a violent gastro-intestinal catarrh. Sour beer and wines that have undergone unhealthy fermentation may in like manner occasion the disease. Excessive draughts of cold water and the use of foul water, especially if mingled with sewage, are often followed by catarrhal enteritis. Witness the diarrhœas that are rife in Chicago after the winter rains have washed the contents of the sewers into the lake from which the drinking water of the city is drawn. Conversely is worthy of note the cessation of diarrhœa among the soldiers in the Civil War when they were made to drink the water of the Mississippi instead of the ditch water in their camps.

A frequent cause of intestinal inflammation lies in sudden refrigeration of the body, especially during copious perspiration. Many an inexperienced youth has lost his life by reason of a plunge when overheated into a cool stream of water, or from a nap under a tree for

which the only preparation consisted in exposure of the sweating abdomen to the refreshing breezes beneath the dense canopy of shade.

Traumatic causes may excite severe intestinal inflammation. Falls, blows, kicks that have invaded the abdominal wall, may result in inflammation of the intestinal tract. In like manner, the introduction of foreign bodies from the mouth or through the anus may excite the disease. Large gall-stones and fecal concretions may act in a similar manner. It is in the same way that long continued constipation may assist in lighting up an inflammation. The action of parasitic guests, such as intestinal worms, amœbæ, and various other microbes, will be fully considered in the appropriate sections of this treatise.

Certain chemical substances may exert a powerful effect upon the gastro-intestinal mucous membrane. Thus the excessive or too prolonged use of mineral waters may excite an intestinal catarrh. Caustic alkalies, the mineral acids, corrosive sublimate, arsenic, tartar emetic, and the various cathartics of vegetable origin may all produce a similar result.

The action of the infectious microbes within the body is frequently accompanied by intestinal inflammation that, occurring under favorable conditions of temperature, atmospheric moisture, etc., may simultaneously affect large numbers of patients at once. A familiar example is presented by many of the epidemics of camp diarrhœa that have decimated whole armies, or by the widespread diarrhœa that often accompanies the invasion of a community by Asiatic cholera. Such epidemics are especially incident among children, young people, and other particularly susceptible subjects during hot, changeable, and unseasonable weather; hence their greater prevalence in the tropical regions of the earth and during the late spring and early autumnal months.

Young children and feeble adults are particularly sensitive to the ordinary causes of gastro-enteritis. This is especially notable among those who have inherited a predisposition to tubercular or arthritic diseases. Their mucous membranes are inordinately sensitive to the excitants of inflammation. In many instances a catarrhal inflammation attacks the respiratory tract, and thence invades the stomach, whence it extends into the intestinal canal. This extension may be due to simple continuity of tissue, or it may depend upon the fact that gastric disorder occasions the passage of undigested or ill-digested food into the intestine, where it excites inflammation by direct irritation of the mucous surface.

An example of invasion of the intestinal tract by contiguous inflammation is furnished by the course of peritonitis, which frequently penetrates the mural tissues of the gut and involves the mucous membrane. Eczema around the anus sometimes extends into the rectum. The rectal surface is also sometimes inflamed by the entrance of gonorrhœal pus that has trickled from the urethra and vagina or has been introduced in other ways.

Direct violence to the mucous surface, such as may be caused by bougies and other foreign bodies that have been forced into the bowels, may excite a catarrh of the intestine. The same result may follow hernial strangulation, invagination, or twisting of the intestine. Compression of the intestines by the growth of abdominal tumors may occa-

sion a degree of stagnation in the blood current that favors the incidence of inflammation upon the intestinal surfaces. In like manner a turgid condition of the intestinal capillaries, caused by obstruction of the portal vein, either by local obstacles or by cirrhosis of the liver or by hindrances to the circulation arising from morbid conditions of the heart or lungs, may suffice to determine the occurrence of intestinal catarrh. Hence the frequency with which such catarrhal conditions are noticed in connection with pulmonary tuberculosis, chronic renal inflammation, and cachexia induced by malaria, syphilis, etc. In fact, there are very few of the infectious diseases of any considerable duration that are not liable to complication by such catarrhal conditions. In many instances convalescence is long retarded by the persistence of gastro-intestinal catarrh. Whether the intestinal inflammation and ulceration that sometimes follow extensive burns of the skin are due to nervous derangement or to simple infection is not yet decided.

Pathological Anatomy.—In severe and fatal cases of acute enteric catarrh the mucous membrane of the intestine remains somewhat thickened and reddened, even after death. The blush of redness may be generalized over the entire surface, or it may appear in spots of irregular shape and size. Sometimes the superficial vessels are rendered more conspicuous by distention, and are bordered by a margin of pink color, presenting a beautiful arborization upon the inner surface of the bowel. When there has been a high grade of inflammation minute extravasations of blood are visible, and the superficial layers of epithelium are in process of exfoliation. The submucous layer of the intestinal wall is often also infiltrated with a serous fluid causing a true inflammatory œdema of the tissue, but in uncomplicated cases the muscular and peritoneal coats of the intestine do not share in the inflammatory process.

The lymph glands that open through the mucous membrane of the intestine appear enlarged, prominent, like little sago grains imbedded in the intestinal lining, and surrounded by a fringe of dilated capillaries. Pressure causes the evacuation of a slightly turbid fluid, showing that the glandular structure participates in the œdematous swelling, and that its elements share in the consequences of inflammatory cellular proliferation. By extension of this process to the deeper lymph glands in the mesentery they also become enlarged and softened.

So far as the pathological appearances that depend upon hyperæmia and swelling are concerned, it cannot be doubted that to a certain degree their intensity is diminished by the reduction of intravascular pressure that follows death. For this reason it is probable that the full measure of pathological change is never displayed upon the autopsy table.

Besides the morbid appearances that have been already mentioned, erosions of the mucous membrane and considerable ulcerations may be occasionally observed. These losses of substance are due to the mechanical effects of the exudative process, either affecting the interfollicular spaces, or to inflammatory necrosis of the glandular elements themselves.

Symptoms.—Many of the symptoms of acute intestinal catarrh are dependent upon perversion of the special functions and anatomical structure of the portion of the bowel that is chiefly affected. Catarrhal

affections of the duodenum and of the portion of the intestine that is connected with the appendix vermiformis will be discussed in another place. We may therefore proceed at once to consider the symptoms of the most common form of intestinal inflammation—ileo-colitis, or catarrhal inflammation of the ileum and colon.

The onset of the disease may be gradually ushered in with prodromal symptoms of general discomfort and indigestion; but in many instances, especially after great fatigue and exposure, the attack is sudden. There is a chill followed by fever, or successive chills and fever may be developed with only a brief interval between the paroxysms. There is considerable thirst; the temperature rises to 101°–102° F.; the tongue becomes red, pointed, and furred; there is a copious diarrhœa, so that sometimes it is difficult to avoid the fear of an incipient typhoid fever; appetite fails; there is considerable prostration of strength, which in severe cases may border on collapse, especially in the case of elderly or enfeebled patients, who are rapidly exhausted by the pain that accompanies the course of the disease. Children and nervous subjects not infrequently manifest some degree of delirium, or even convulsions, which in such persons often replace the chills that ordinarily occur.

The most constant and conspicuous symptom is diarrhœa. The number of the stools varies with the severity of the attack; sometimes the impulse to defecation is constant, and the patient can scarcely leave the seat of the commode or water-closet. Increased peristaltic action determines this phenomenon, but the quantity and quality of the fecal discharges are dependent upon the quantity and quality of the food, and also upon the amount of inflammatory exudation from the mucous lining of the bowel. During the initial stage of the attack the stools contain masses of undigested food mixed with more or less perfectly formed fæces. To these evacuations of the normal contents of the intestinal canal succeed discharges of a semifluid consistence, at first colored with bile, but soon followed by watery stools that contain very little if any biliary pigment, and are mixed with a considerable quantity of mucus, which is often streaked with blood. The color of the stools now varies from a light yellow to a gray, light brown, or greenish tint. Frequently the stools become green in color after exposure to the air. In severe cases the discharges finally become very fluid, and contain a great number of epithelial cells that have been thrown off from the mucous membrane, so that the stools look as if composed of rice water, or, if they contain blood pigment, like water in which raw beef has been washed. The normal fecal odor disappears, and is replaced by a smell like that of prostatic mucus and semen. In certain cases masses of fermenting or putrefying matter may be voided if the diet of the patient has been unfavorable to digestion.

It often happens that the disease, especially when associated with acute gastritis, rushes rapidly to a fatal termination. One or two days or a week may hurry the patient into a fatal collapse. In many instances a number of weeks may elapse before a decision is reached, and the sufferer, now better and now worse, is buffeted by the waves of alternate hope and despair. Sometimes the disease gradually assumes the form of a chronic enteritis, which may none the less certainly prove

fatal, though prolonged for many months. But in milder attacks the severity of the symptoms relaxes after a few days; the stools recover a fecal odor and consistency; painful diarrhœa ceases; and presently all is well again, though for a long time the intestinal canal may remain inordinately sensitive to every cause of irritation.

Among the various symptoms of acute enteric catarrh may be particularized a notable distention of the abdomen. By the processes of fermentation and putrefaction the bowels become inflated with gas, causing great increase of tympanitic resonance over the whole of the belly. The different coils of intestine are thus sometimes rendered evident through the abdominal wall, and their peristaltic movements may become visible if the patient be somewhat emaciated. The diaphragm is crowded upward by gaseous pressure, and the heart and lungs may be considerably displaced and embarrassed in function. The liver also may be lifted above the margin of the costal border. The passage of fæces through the anus is often accompanied with an outbreak of flatus that gives only temporary relief. Conversely, the attempt to void wind is often followed by a simultaneous discharge of liquid matter. With these movements there is an audible gurgling and bubbling sound that marks the transfer of air and water from one intestinal coil to another as their contents are urged onward by peristaltic action.

The variable color of the stools has been already noted. Their consistency also varies with the amount of water and mucus that they contain. During the early stage of the disease numerous relics of food are evident in the dejecta, and sometimes intestinal worms or other parasites may be discovered in the discharges. Sometimes, when the patient has previously suffered long with obstinate constipation, hard and gritty masses of dried-up fecal matter—genuine coproliths—become dislodged from the intestinal sacculi, and are revealed to the eye along with the other intestinal contents and products of inflammation. Microscopical examination of the stools renders visible all the débris of the food that has been swallowed, such as muscular- and connective-tissue fibres, starch grains, fibres and cells from plants, and droplets of fat. Epithelial cells from the intestinal mucosa are very numerous, together with the round cells and blood-corpuscles—white and red—that follow the course of inflammation. All the varieties of bacterial growth that are native to the intestine are visible, but it is not usual to encounter any particular pathogenic microbes in uncomplicated cases. Numerous crystals may be discovered, such as the ammonio-magnesium phosphate, the neutral calcium phosphate, calcium oxalate, cholesterin, and the so-called Charcot's crystals.

The urinary secretion is greatly reduced in quantity, and during the period of copious diarrhœa it may be almost completely suppressed. It is frequently loaded with urates, is strongly acid, and its passage is sometimes followed by painful scalding sensations in the urethra. Occasionally the urinary sediment contains red blood-corpuscles, round cells, renal epithelium, and hyaline casts. Albumin may be also present in the urine. In certain cases the spleen is perceptibly enlarged.

The febrile movement that accompanies the disease is variable: sometimes the temperature rises to a degree and persists for a period

that awaken a suspicion of typhoid fever. Successive chills sometimes occur, and, if the patient be a child or an unusually excitable person, convulsions and delirium may diversify the picture.

The duration of the disease may be limited by one or two days, or it may continue for as many weeks. The period of convalescence is often marked by considerable debility.

When the inflammatory process is confined to the mucous surface of the small intestine diarrhœa is absent. The watery exudations under such conditions are reabsorbed in the colon, and do not reach the anus. Colicky pains about the umbilicus, loss of appetite, some slight febrile reaction, and a general feeling of prostration are the principal symptoms. Considerable information may be derived from a microscopical examination of the stools, which in such cases contain minute masses of mucus mixed with fecal matter, and are often colored with bile pigment which can be demonstrated by Gmelin's test. Still more valuable indications are furnished by the urine, in which, as a consequence of putrefactive changes in the small intestine, the presence of indican may be readily demonstrated by the hydrochloric acid test.

Inflammation of the cæcum and vermiform appendix are considered in another part of this volume. (See Appendicitis, p. 277.) The symptoms of colonic catarrh are merged in and associated with those of inflammation of the small intestine to such a degree that they cannot be separately described, and they have been already sufficiently narrated.

When the mucous membrane of the rectum is the principal seat of inflammation, the impulse to defecation is more urgent than in disease of the upper segments of the alimentary canal. Tenesmus is very severe, and there is frequently considerable tenderness on pressure over the left iliac fossa. The patient is continually tormented with colicky pains in the lower portion of the abdomen, and by an incessant impulse to void the rectal contents. These consist chiefly of mucus mixed with a variable quantity of blood, and they are rendered further notable by the complete absence of fecal matter or by its very rare appearance. Digital examination finds the rectum hot, swollen, and sometimes closed by spasm of the sphincter ani muscle. The mucous membrane is red, rough, and covered with mucus. After the inflammation has continued for a considerable time, as in chronic diarrhœa, a paralytic condition of the rectal and anal muscles succeeds the previous state of spasm, and the anus gapes open, permitting the acrid products of inflammation to flow forth over the buttocks. Severe intertrigo may be thus set up. Sometimes there is prolapse of the rectum, and in severe cases the inflammatory process may invade the perirectal tissues and create an abscess, with subsequent formation of a fistulous canal between the rectal pouch and the external surface of the body.

Diagnosis.—Acute enteric catarrh is easily recognized. During the prevalence of an epidemic of Asiatic cholera the question may be raised as to the possibility of mistaking the one disease for the other, but a microscopical examination of the stools will soon decide which of the two maladies is present. The absence of the cholera bacillus determines in favor of the simple catarrhal affection. In like manner, the discovery of typhoid bacilli in the stools or in blood drawn from the

spleen or roseolous spots decides in favor of typhoid fever. The course of the temperature and the occurrence of the well-known eruption at the end of the first week also furnish corroborative evidence. With other intestinal disorders the disease can hardly be confounded.

Prognosis.—Only in cases that are complicated with serious disease of other important organs, or in cases that have been enfeebled by other causes, is the prognosis discouraging. When the conditions for convalescence are unfavorable, frequent relapses follow slight errors of diet or exposure, and the disease may become transformed into a chronic intestinal inflammation.

Treatment.—In every acute inflammation of the alimentary canal, especially if pain and fever be present, the patient should be kept in bed. A warm poultice or a hot fomentation should be laid over the entire surface of the abdomen, and should be covered with thick woollen cloth or oiled silk or thin rubber tissue. For travellers the specially prepared artificial linseed poultices are invaluable. When painful colic is a prominent symptom a drachm of chloroform may be stirred in with the hot water and meal during their preparation for the cataplasm. The patient must be furnished with rice water, crust coffee, hot milk, or pure water for his drink. Only liquid food should be permitted, such as hot milk, barley gruel, oatmeal gruel, or gruel prepared from any one of the various food powders that are furnished for infants. In short the diet should be that of a newly weaned infant. Animal broths, such as clam broth, oyster broth, chicken broth, and veal broth, may be allowed. Alcoholic stimulants should only be given in cases of collapse when the stomach is not seriously inflamed. As a general rule, the gastro-intestinal mucosa when suffering inflammation is very intolerant of alcohol, or should receive it only in a state of high dilution.

At the commencement of the disorder, especially if it has been preceded by imprudent use of food or by the ingestion of unwholesome or corrupted articles of food, such as tainted meats, etc., the alimentary canal should be evacuated without delay. Ten grains of calomel with five grains of sodium bicarbonate should be administered in a wafer, and this should be followed within an hour by a tablespoonful of castor oil. The oil may be floated upon a spoonful of coffee or of orange-juice, or it may be mixed with the froth of beer. The older physicians usually employed the powder of jalap in connection with calomel, but this drastic purgative should only be used among the most vigorous patients. For women and children small doses of calomel may be given at short intervals, followed by a glass of the solution of magnesium citrate or by half a glass of Rubinat water or by a Seidlitz powder or a drachm or two of Rochelle salts. By thus relieving the intestine of all its irritating and toxic contents recovery may be often reached without additional treatment.

But if, in spite of such thorough evacuation of the intestines and drainage of the capillaries of the mucosa, diarrhœa should still persist, it will be found necessary to combat the inflammation by the use of remedies that are antiseptic and astringent. Most useful in this stage are the compounds of bismuth. The salicylate, the subnitrate, the subcarbonate, or the subgallate of bismuth may be administered in ten-grain doses after each movement of the bowels. Half a grain of opium,

and in cases marked by cardiac weakness a grain of camphor, may be added to each dose. In certain *quasi* choleraic conditions, when a positively styptic effect is desirable, recourse should be had to the mineral astringents, such as acetate of lead, nitrate of silver, alum, sulphate of iron, solution of the persulphate of iron. These should be combined with opium sufficient to prevent irritation and to calm pain. As the case progresses and a tonic astringent influence is needed the vegetable astringents should be employed. These are numerous, but owe the greater part of their efficiency to the tannin that they contain; hence the reputation that is connected with decoctions of strawberry or raspberry or blackberry leaves. Tannic acid may be given in doses of two to five grains every two or three hours. The various extracts and tinctures of catechu, krameria, hæmatoxylon, and coto bark are often useful in conjunction with opiates, especially the camphorated tincture of opium. After convalescence is established great care is needful to avoid errors in diet and exposure to cold. For many patients a woollen band should be ordered, to be worn around the abdomen even after complete restoration to health.

When inflammation is restricted to that portion of the intestine which lies below the ileo-cæcal valve, local treatment may be added to the methods just described. The colon may be irrigated by the aid of a fountain syringe containing a quart or more of warm water, to which a teaspoonful of table salt has been added. By placing the patient in different positions, so as to favor the expulsion of gas previous to the entrance of water, the colon may be easily filled and thoroughly washed out. Great comfort, extending even to a whole night's sleep, may be often procured by this simple expedient. If the disease does not yield promptly, and especially if it tend to become chronic, this irrigation of the bowel may be followed by an equally extensive application of a weak solution of silver nitrate to the mucous lining of the colon and rectum. The solution should be very weak at first—one part of the nitrate to one thousand parts of water, half a grain to the ounce, or fifteen grains to the quart. As tolerance becomes established the strength of the solution may be gradually increased to four or five times the original figure.

If the course of the inflammation be attended with colic that does not yield promptly to the ordinary doses of opium by the mouth, it will be necessary to resort to the use of morphine and atropine hypodermically. For this purpose the soluble tablets that contain the two drugs to the amount of one quarter of a grain of the first and the one hundred and fiftieth of a grain of the last should be employed.

When the inflammatory action chiefly involves the rectal mucosa, great relief from tenesmus may be obtained, after the bowel has been cleansed by irrigation, from the use of rectal suppositories that contain morphine and atropine. The equivalent of one of the soluble tablets just mentioned may be incorporated with a little cocoa butter, and then is introduced by the aid of a suppository holder above the internal sphincter of the anus. Unless thus placed high up in the rectum it may aggravate the desire to stool.

CHRONIC INTESTINAL CATARRH.

Etiology.—Chronic inflammation of the intestinal mucosa may be determined by the gradual passage of an acute attack into the prolonged variety of the disease, or it may result from frequent relapses of the acute form, due to many different causes that either retard or arrest convalescence. The causes that excite acute inflammation of the mucous lining of the intestine may therefore in this sense be reckoned as causes of chronic inflammation. But the real causes that convert an acute attack into a persistent disease are undoubtedly of a different nature. The same thing may be said of the conditions that favor the gradual incidence and evolution of a primarily chronic catarrh of the intestine. All causes that operate to embarrass the abdominal and intestinal circulation of blood and lymph are thus prejudicially active. Hence the universal association of catarrhal conditions of the intestine with cardiac and pulmonary disease, hepatic disease, portal obstruction, etc. Certain toxic conditions also favor the development of intestinal catarrh. Prominent among these may be mentioned malarial poison, tubercular excreta, and the toxins that are generated in gouty states of the body or during the course of renal diseases. Many severe and protracted cases owe their existence to the pernicious activity of parasitic protozoa in the large intestine.

Pathological Anatomy.—On opening to inspection the intestine in a case of chronic catarrhal inflammation the mucosa is found evidently thickened, changed in color, and covered with a rather tenacious layer of mucus. The swelling of the membrane is conditioned by the inflammatory increase of the connective-tissue elements throughout both the mucous and the submucous layers of the intestine. The lymphatic follicles and their appendages are also increased in size. When this hypertrophic condition obtains the vessels of the mucosa and submucosa exhibit a thickened parietal structure and the veins are somewhat dilated. In cases of moderate duration the inner surface of the intestine is of a dark red color, owing to excessive vascularity associated with protracted stagnation of the blood. But in cases of long standing the same surface may present a dark, slaty hue by reason of the accumulation of blood pigment in the extravascular tissues and spaces. A favorite seat of such pigmentation is found in the coronal network of capillary vessels that surrounds every lymph follicle and intestinal gland. Hence the prominence that by this method of staining is given to the orifices of the follicles and glands that open into the intestinal canal. They also yield a more or less abnormal secretion—sometimes watery, sometimes slimy, sometimes sero-purulent or puriform—that smears the free surface of the mucous membrane.

The terminal consequences of chronic intestinal catarrh may be hypertrophy or atrophy of the intestinal wall, or it may result in chronic ulceration of the parietal tissues. In many instances all these changes may be associated in the same subject.

When, as a consequence of catarrhal inflammation, hypertrophy of the intestinal wall is produced, the increased thickness of the mucosa may actually cause an appreciable reduction of the diameter of the intestinal canal. This change is most conspicuous in the small intestine,

where the swollen valvulæ conniventes make themselves prominent, and also in the region of the ileo-cæcal valve. The connective tissue becomes increased in amount, and sometimes the peritoneal investment of the gut exhibits evidence of thickening and loss of translucency through similar exudative and proliferative processes involving its serous surface.

Intestinal atrophy is not an uncommon event in cases of chronic catarrh, such as occur among children and weakly individuals. The intestinal wall becomes extraordinarily thin, and the glandular and muscular structures undergo atrophy. The cæcum appears to be the central focus of this process, which extends in lesser degree upward and downward through the intestinal canal.

Ulceration of the intestinal lining originates in two different ways—either as a simple solution of continuity in the substance of the mucosa, or as a necrotic inflammation of a follicular sac that lies imbedded in the intestinal wall. The first variety is originated by a superficial erosion at some point upon the mucous surface. Of a circular form at first, the necrotic process and the coalescence of neighboring erosions finally convert the growing ulcer into an irregular excavation with overhanging borders that are undermined by inflammatory action in the submucous tissue. Sometimes an islet of mucous membrane that has escaped death remains visible in the centre of an ulcerated patch. Granulations sometimes spring up along the border of the excavation, and serve to increase the irregularity of its margin.

As a consequence of the suppuration that accompanies ulceration submucous abscesses are sometimes formed. These burrow among the tissue elements of the intestinal wall, and may result in actual perforation of its peritoneal investment. So long as ulceration is confined to the intestinal coats a discharge of pus with the fæces may be the only visible product. But sometimes a blood vessel is eroded, and hemorrhage quickly follows. When the peritoneal cavity is opened by perforation the intestinal contents are not always permitted to enter that serous sac. Adhesions to an adjacent surface of intestine, stomach, liver, or other abdominal organ frequently result, and the ulcerative opening is thus sealed up. Sometimes pus accumulates in a cavity that is thus formed by marginal adhesion between two intestinal folds or peritoneal surfaces. Such abscesses, however, are liable to enlarge, and gradually work their way to a great distance along the line of least resistance. They may finally form a communication with any of the cavities, vessels, or hollow viscera of the abdomen and thorax, or they may penetrate the abdominal wall and thus reach the external world. When adhesive inflammation fails to form an adequate wall for the advancing abscess, the peritoneal cavity is liable to be invaded by a fæcopurulent discharge, setting up violent peritonitis that is usually fatal in a very short time.

When the ulcerative process can be checked cicatrization may be completed after a time. But even this favorable result may have disadvantageous consequences. The overlying peritoneum becomes thickened, and the frequently pigmented scar undergoes contraction to an extent that sometimes occasions notable deformity and stenosis of the intestine.

The process of exudation, that in the early stage of inflammation occasioned simple swelling and thickening of the intestinal mucosa, may invade the structure of the solitary lymph follicles that are so numerous in the wall of the colon. The glandular elements increase and crowd upon one another until necrosis begins. By this process the cavity of the follicle becomes filled with dead and dying caseated cells which are loosened and thrown off into the fæces. In this way the intestinal wall is studded with a vast number of minute excavations which are real microscopic ulcers. In the walls of these cavities the ulcerative process goes on, undermining the mucosa and enlarging in every direction, so that finally, by the coalescence of numerous openings, ulcers of great extent and depth are formed. It is in the colon that this result attains its greatest development, but sometimes the rectum also shares in the results of the destructive process. In these ulcers may be frequently discovered the little sago-like masses that often appear in the stools. When cicatrization occurs the resultant scar is smooth and pigmented like the corresponding scar that is formed by the healing of the ordinary intestinal ulcer of erosive origin.

In certain cases the connective tissue of the intestinal mucosa proliferates so actively, under the stimulus of inflammation, that numerous polypous excrescences appear upon its surface. These polypi are most numerous throughout the length of the colon, and may be sometimes found intruding into the rectum. Occasionally the inflamed follicles in the mucous membrane do not ulcerate, but, becoming obstructed by closure of their orifices, they develop into cysts in the intestinal wall. In this way the inner surface of the colon may be considerably diversified by the formation of ulcers, polypi, and cystic cavities.

Symptoms.—Chief among the symptoms of chronic catarrhal inflammation of the intestine are changes in the character of the stools and in the process of defecation. Intestinal torpor and infrequent evacuation of the bowels are among the earliest consequences of the reduction of muscular vigor that results from chronic inflammation so near to the muscular coat of the intestine. Probably the nervous mechanism of the intestinal wall suffers in the same way, so that its response to irritation by the fecal contents of the gut is less prompt and efficient. Periods of diarrhœa frequently alternate with corresponding periods of constipation, just as in the inflamed bronchi and trachea violent fits of coughing succeed to seasons of calm during which the products of inflammation accumulate in the respiratory passages. In many cases, however, frequent loose stools are voided every day, or they may occur only in the morning, leaving the patient in comparative comfort during the greater part of the day and night.

The stools generally contain an abnormal quantity of mucus. Even if the fæces are cylindrical and semi-solid, they are often covered with an abundant coating of slime, in which may be sometimes discerned the presence of blood and pus. Mucus is more liberally furnished as the inflammatory process approaches the rectum, and when that portion of the intestinal canal is invaded, the discharges often consist almost entirely of mucus. Blood and pus are evidences of ulceration, and so were once considered the sago-like masses of starch that sometimes make their appearance, though occasionally they exist in simple cases

that have not yet reached the ulcerative stage. When the stools are thin and watery by reason of rapid propulsion through the intestinal canal, they not infrequently contain undigested fragments of food that have been hurried downward from the stomach. Microscopical examination of the stools will readily differentiate these particles from the variously degenerated epithelial and connective-tissue cells that exist in the discharges. By the same method it is possible to detect the ova of the different worms that sometimes inhabit the intestines, and to discover the amœbæ coli and other parasites that may excite inflammation of the mucosa.

There is a form of chronic intestinal inflammation that is characterized by the production and exfoliation of pseudo-membranous masses or pellicles that sometimes present the appearance of casts of the mucous membrane. In certain cases they are solidly cylindrical, like hyaline casts from the renal tubules. In others they are hollow or flattened and band-like, resembling the mucous lining of the intestine itself, or, to the eyes of the laity, presenting the forms of dead and tape-like worms. Treated with chemical reagents, these false membranes are found to be composed chiefly of mucin, albumin, fibrin, and globulin. Occasionally a low form of incipient organization may be discovered, and rudimentary bloodvessels are visible in the extruded mass. But this is unusual, and the substance must be ranked as a pellicular exudation that is formed as a result of chronic inflammation, very much as the vegetations that form upon the inflamed valves of the heart are produced. Sometimes, however, these membranes appear to exist independently of inflammatory action. In such cases they are probably the result of perverted secretion and of a disturbance of the trophic functions of the nervous mechanism of the alimentary canal. This hypothesis is rendered probable by the fact that many of these patients are middle-aged, neurotic, neurasthenic, and hypochondriacal females with blue eyes, fair complexion, and other evidences of delicate organization. The discharge of a false membrane is usually preceded by long-continued constipation and by the frequent occurrence of colicky pains in the umbilical region. Sometimes the whole mass is voided at once, usually with the ordinary fecal discharge; but sometimes it appears at intervals in divided fragments, with or without the fæces. Sometimes these deliveries are of frequent occurrence, but in many instances they are effected only at long intervals of time.

The uneasiness that is occasioned by chronic catarrhal inflammation of the intestines is frequently aggravated by the accumulation and movement of gas in the bowels. This difficulty is increased by the use of certain articles of food, notably those of vegetable origin. Such flatulence originates some time after eating, and is caused by the fermentation or putrefaction of the contents of the intestine.

When the bowels are moved only at considerable intervals of time, the colon is the principal seat of gaseous production resulting from putrefaction of the retained fæces. Accordingly, the act of defecation is often preceded by colicky pain in the lower part of the abdomen, and great relief is experienced after expulsion of the intestinal contents. If the small intestine be distended also, the descent of the diaphragm is hindered, and there is complaint of pseudo-dyspnœa. Often in such

cases the heart is disturbed in its action and beats violently or irregularly, causing considerable interference with the circulation of blood. Various nervous phenomena, sometimes of an hysterical character, may appear. Dizziness, flushing of the face, and throbbing in the temples are not uncommon events in such cases. The extremities are usually cold, and the pulse is habitually feeble, owing to the great impoverishment of the blood, which sometimes reaches to a degree that is suggestive of the most dangerous forms of anæmia. The urine also becomes scanty, and is often loaded with brickdust sediment. Under such circumstances the patient becomes gloomy, hypochondriacal, sleepless, and sometimes even insane. These changes are due to imperfect nutrition of the tissues and intoxication of the brain with the products of intestinal decomposition.

The duration of chronic intestinal catarrh is very lengthy—sometimes it coincides with the life of the patient. In extent it sometimes pervades the whole intestine, but it is occasionally limited to a particular portion of the bowel. Usually it involves the ileum and the colon at the same time. When seated in the upper portion of the small intestine it is generally associated with chronic gastric catarrh, and is indicated by chronic jaundice and by the presence in the fæces of microscopical particles of mucus and epithelium that are colored with bile. In cases of chronic inflammation of the ileum there is an increase of indican in the urine, but beyond this there are no reliable symptoms of an uncomplicated inflammation limited to that portion of the gut. In chronic inflammation of the rectum there is a certain amount of tenesmus, but it is far less urgent than during an acute inflammatory attack. Sometimes the discharges consist chiefly of muco-purulent matter, and sometimes there is prolapse of the rectum, followed by an irritating intertrigo upon the soft parts around the anus. Occasionally the inflammatory process extends into the perirectal connective tissue, causing abscesses and subsequent *fistulæ in ano*.

Ulceration of the intestinal mucosa, especially in its colonic portion, tends to become permanent. The presence of pus or of pus mingled with blood in the stools is an almost certain indication of such lesions. When ulceration is confined to the rectum and lowest portion of the colon the fecal cylinder, though normally consistent, will carry pus, blood, and mucus upon its surface. Rectal ulcers can be recognized by the touch or by the use of the rectal speculum. The minute sago-like bodies that are often present in the fæces, and were formerly held in high repute as indicative of the existence of follicular ulcers in the colon, are now believed to have their origin in undigested starch from the food, and they are often present in the stools when ulceration is unknown. The presence of broken-down connective tissue in the intestinal discharges is a very rare event, but one of great diagnostic value when it occurs. It should never be forgotten that diarrhœa is often absent in cases of circumscribed inflammation and ulceration of the intestinal canal, so long as the greater portion of the mucous membrane remains intact.

Diagnosis.—So characteristic are the phenomena of chronic catarrhal enteritis that a review of the symptoms is sufficient for the establishment of the diagnosis. Since identical symptoms may follow inflam-

mation that has been excited by various causes, a careful investigation is often needful in order to determine the origin of the disease. Some difficulty may attend the effort to localize the lesions of the mucous membrane, but this can be surmounted by careful observation. Even though complicated by peritoneal or other abdominal disorders, the character of the stools suffices to explain the nature of the disorder.

Prognosis.—Chronic catarrhal enteritis is a disease that often persists for a lifetime. Under favorable conditions it may continue for many months or for a number of years. To life it is most dangerous during the extremes of childhood and old age. When caused by incurable disorders or associated with permanent diseases, such as tuberculosis, chronic nephritis, degeneration of the liver, heart, etc., it often becomes the despair of the therapeutist. Death often results from intercurrent diseases that are rendered dangerous and incorrigible by the cachexia that underlies the mucous inflammation itself. In elderly patients who are the victims of the gouty predisposition various renal, cardio-vascular, and respiratory diseases are often associated with the course of chronic enteritis, and are frequently the determining cause of death.

Treatment.—In every case of chronic catarrhal inflammation of the bowels the patient must be guarded against sudden chilling of the external surface of the body. Warm clothing in the winter and sufficient protection in the summer are essential to health. Many persons, even in tropical countries, find it necessary to wear a flannel bandage around the abdomen through the entire year. During the cooler hours of the morning and evening thicker clothing must be worn, and the bed-clothing must be sufficient to protect against chilliness during the hours of sleep.

The diet must be carefully regulated. Unless some personal idiosyncrasy should prevent, milk should constitute the principal portion of the food. It should never be taken cold, except in the form of frothy koumyss. Nor should it be boiled, for by that process it is deprived of its antiscorbutic properties. Simply heated to a temperature of 160° F. and taken at the temperature of ordinary hot drinks, it is palatable and curative. The starchy elements of food are best represented by rice that is cooked in a steamer, so as not to be stirred into a pasty condition. Well salted, it may be eaten with hot milk, and should be so thoroughly masticated that every kernel is reduced to pulp in the mouth. With this may be eaten the thick crusts of Vienna bread, zwieback, toasted crackers, and toasted bread that has been thoroughly dried in the oven before it is torrefied at the fire. A small quantity of butter may be permitted with this food, unless there be an over-acid state of the stomach. Soups and broths that have been thoroughly strained, cooled, skimmed free from fat, and freshly heated are usually well tolerated. Stewed maccaroni and vermicelli are also excellent articles of food when not prepared with cheese or other substances that are difficult of digestion.

But when starchy food does not agree with the gastro-intestinal mucosa, the patient becomes uncomfortably flatulent, and it is necessary to make larger use of animal food. Very tender meats thoroughly chewed, minced meat, scraped raw beef, uncooked oysters, soft eggs,

and hot milk should form the principal portion of the diet until convalescence is fairly established. In many cases great benefit is derived from the use of fermented milk. I have seen an obstinate case yield to koumyss taken in portions of a mouthful once every half hour. The fermented *poi* that forms the principal food of the Pacific Islanders is an excellent article in these cases.

The selection of drugs with which to medicate chronic catarrh of the intestinal mucous membrane is dictated by the topography of the disease. When the upper portion of the intestine suffers, there is constipation; when the ileum and colon are involved, there is diarrhœa; when the rectum is the seat of inflammation, there is bloody diarrhœa and tenesmus. Accordingly, in upper intestinal catarrh it is necessary to administer laxatives. It is well to administer a few gently evacuant doses of calomel and podophyllin:

℞. Hydrargyri chloridi mitis, gr. $\frac{1}{6}$;
Resinæ podophylli, gr. $\frac{1}{4}$;
Sodii bicarbonatis, gr. j.
Tabella una fiat.
Sig. One such tablet every four hours till the bowels are moved.

Then the solubility of the fæces may be maintained by subsequent exhibition of pills containing aloin, strychnine, and belladonna, or compound rhubard pills, or aloes and myrrh pills. The compound licorice powder of the German Pharmacopœia is an excellent household laxative that may be given in doses of one or two teaspoonfuls in a glass of water every night or morning. Certain aromatic cordials containing fluid extract of cascara sagrada are often of great service, since they are at the same time laxative and tonic. A very pleasant laxative, prepared from the pulp of tamarinds, may be found in the shops under the form of a conserve. Various fruit syrups reinforced with an electuary of senna are frequently employed by the laity, and are not without value. A teacupful of wheat bran, moistened with water and swallowed before breakfast, is for many a most effectual and agreeable laxative. It is the basis of certain invalid foods that are announced as curative of constipation. Sometimes an increase in the quantity of water that is drank—a tableglassful on rising and retiring—is sufficient. When there are evidences of constipation from nervous irritability the action of belladonna is often favorable. This substance may be given alone in doses of one quarter of a grain of the extract two or three times a day, or it may be combined with other laxatives in pill form.

In many cases of chronic catarrh involving the small intestines great benefit often accrues from the use of the bitter saline mineral waters. Of these, the Saratoga waters afford an admirable example. Of the European waters the Rubinat spring is one of the best. From four to six ounces of the water should be taken on rising in the morning. Followed shortly after with a glass of ordinary table water, the bowels will be evacuated without pain or other disagreeable effect. The German waters from Friedrichshall, Hunyadi Janos, Püllner, or Seidlitz may be used in the same way, either at the springs or at home. For those who cannot afford the luxury of bottled waters, solutions of Epsom

salts or Glauber's salts may be prepared by any apothecary. Epsom salts are to be preferred when the tongue is fairly clean; the sodic sulphate when the tongue is coated and yellow.

Inasmuch as chronic catarrh and constipation are associated with inefficient muscular action in the coats of the intestine, general muscular gymnastics are to be recommended. Massage and kneading of the abdomen may be useful. Faradization of the abdominal wall is indirectly beneficial in a similar way. The introduction of the negative pole into the rectum is often followed by active peristalsis, very much like that which is excited by the introduction of a glycerin suppository or a glycerin enema into the bowel.

When the colon is involved in the catarrhal process, so that we have to deal with an ileo-colitis of chronic character, the treatment must consist in the evacuation of the bowels, their disinfection, and medication with astringents, very much after the manner of treatment that is useful in acute ileo-colitis. Much benefit is to be obtained from daily irrigation of the colon with salt water at the temperature of about 105° F. For this purpose the water of the Glenwood Spring in Colorado and the Carlsbad water in Europe may be recommended. When ulceration of the colon exists, these irrigations may be followed by a subsequent daily enema consisting of a weak solution of nitrate of silver. The value of antiseptic injections is well illustrated by the effects of enemas of brandy, which are sometimes employed by the laity. Though intensely painful, they are very effectual in the production of cure. Far milder, and perhaps equally beneficial in cases of chronic ulceration, is the effect of oil—castor oil or olive oil—taken daily for several weeks in succession.

When chronic ileo-colitis is complicated with malarial infection, removal to a healthy locality is the most essential pre-requisite to a cure. Many a victim of camp diarrhœa in tropical and subtropical countries has lost health and life through neglect of this precaution. Pure air for the lungs, pure water for the stomach, and cold sponge-baths for the skin are often the most helpful agents in these cases. When to these are added simple and wholesome food, like milk and fresh ripe fruits (grapes, apples, oranges), there is little left to be desired.

In the membranous forms of ileo-colitis we encounter some of the most incorrigible cases that can be presented. The internal administration of arsenic and hæmatopoietic stimulants afford, in conjunction with the other measures above mentioned, the best means of relief. It is always necessary to take into consideration the anæmic, neurotic, and neurasthenic condition that underlies the local affection in these patients.

Of various pathological conditions of the intestine, such as diffuse phlegmonous inflammation of the intestinal wall, or fibrinous inflammation of the same structures sometimes discovered *post-mortem* after severe diarrhœa, dysentery, typhoid fever, etc., nothing need be said in this connection, since they cannot be recognized clinically during the life of the subject.

NERVOUS DIARRHŒA.

SYNONYMS.—Diarrhœa nervosa; Nervöse diarrhoe.

Delicate, nervous, neurasthenic, and hysterical individuals under the influence of unwonted excitement of any kind are often subject to a transient diarrhœa that can be explained only by the hypothesis of an increased peristaltic action through the intervention of the nervous system. In a somewhat similar way are to be explained the gastric and intestinal crises, marked by violent though brief vomiting and purging, that occur during the course of a central disease of the spinal column, such as tabes dorsalis.

In many of the victims of gastro-intestinal dyspepsia there may be an almost constant peristaltic movement of the intestines that gives rise to great uneasiness. Sometimes it assumes a real colicky severity, and causes constipation of the bowels by its irregular and retrograde movement of the intestinal muscles. It is usually experienced by the victims of neurasthenia and by women who suffer with uterine diseases or with hysteria and hypochondria.

The TREATMENT resolves itself into management of the diet, exercise, hydropathic measures, and gentle laxatives.

INTESTINAL ATONY; CHRONIC CONSTIPATION.

SYNONYMS.—Atonia enterica; Darmatonie.

ETIOLOGY.—Hereditary causes are active in the production of this very common disorder. Especially frequent is it in families where the possession of wealth exists without knowledge of its use for the production of happiness. Like the other disorders of nutrition that are frequently associated with and aggravated by it, intestinal atrophy is often the result of faulty habits that have been acquired by a previously healthy individual. Thus, it is frequently experienced by members of the mercantile class, professional people, students, seamstresses, shoemakers, and others who have exchanged an active out-door life for the muscular torpor of a sedentary occupation.

Chronic intestinal atony is frequently induced by habitual neglect of the calls of Nature to stool. By reason of pre-occupation with business cares or through ignorance of the consequences of neglect, regular habits are not maintained, and the normal daily incitement to evacuation of the bowels ceases to make itself felt. During cold weather in the country the cheerless lack of comfort and convenience about the out-houses leads women and children to postpone the act of defecation until frequently the habit has been lost.

Diet is of great importance in chronic constipation. Comparison of the fæces of a dog with those of a calf shows that vegetable food furnishes a more copious supply of fecal matter than is yielded by animal food. Accordingly, it is a daily observation that people who live upon flesh, milk, eggs, cheese, etc. are much more prone to constipation than

the inhabitants of tropical countries, who live on rice, potatoes, fruits, and starchy preparations. Still, it is noteworthy that vegetable food does not wholly counteract the effects of inactivity and muscular weakness. Under such conditions fecal stagnation may distend the atonic bowels, and thus exaggerate the difficulties of the case. The same thing may be often observed among infants who are brought up by hand on cow's milk. This form of constipation is due, in part, to the difference between mother's milk and that of the lower animals, and in part to the imperfect nutrition of the ill-fed child. It is usually the fact that delicately organized individuals, with slender muscles and feeble nerves, are constant sufferers from debility of the intestinal muscles. Acquired atony of these muscles is an almost uniform consequence of debilitating diseases, chlorotic and anæmic conditions, and neurasthenia. Overactivity of the brain and its chronic disorders, such as hysteria, hypochondria, and melancholia, are fruitful causes of intestinal atony. It often originates during convalescence from exhausting diseases, and is almost always experienced at some time in the course of other intestinal maladies. Among old people it frequently results from the atrophy that accompanies senility. At the other extreme of life it is not a common affection before the age of puberty and the formation of sedentary habits at school or elsewhere.

Symptoms.—The most conspicuous symptom of intestinal atony is persistent constipation. Instead of the daily impulse to evacuation of the bowels, the patient often passes many days without a stool; sometimes the call to defecation is only experienced while under the influence of laxative or purgative drugs. In such obstinate cases the fæces become very dark in color, and they are sometimes hardened and dried like masses of charcoal. The normal fecal odor is lost, and is replaced by a peculiar stench that is characteristic of imperfect defecation. The fecal cylinder undergoes various modifications of form: sometimes it is transformed into bulky masses of irregular shape, more or less moulded by the sacculi of the colon; sometimes it is disintegrated into little pill-form shreds that resemble beans or the dung of sheep and goats; occasionally it assumes the form of slender, long-drawn-out cylinders, as if passed through a narrow stricture. Frequently the fæces are smeared with mucus and are marked with fresh blood.

The effects of chronic constipation are very notable in their influence upon the functions of the brain. There is a feeling of universal discomfort, fulness and pressure in the head, throbbing in the temples, ringing in the ears, dizziness, and faintness if exposed to great heat. Great depression of the spirits, extending even so far as hypochondria and melancholia, are not infrequent. These disturbances are chiefly consequent upon insufficient defecation of the tissues, and upon their auto-intoxication with poisonous toxins that are absorbed from the stagnant intestinal pool. It is in this way that respiratory oppression, cardiac palpitation or intermission, insomnia, and transient attacks of ephemeral fever are excited.

Physical examination of the abdomen frequently reveals a distended condition of the colon, and sometimes isolated fecal masses can be distinguished through the abdominal wall. These fecal tumors usually

occupy the descending colon above the sigmoid flexure. They are not painful on pressure, and, if not too much indurated by long residence, they can be indented by firm compression between the thumb and fingers. Hemorrhoids are frequently coincident, and sometimes there is prolapse of the rectum as a consequence of excessive straining at stool.

Diagnosis.—It is not always easy to distinguish between simple intestinal atony and other diseases attended with chronic constipation. Chronic intestinal catarrh, most frequently confounded with atony of the bowels, may be differentiated by the fact that the constipated fæces in catarrh are often covered with mucus and blood, while in cases of uncomplicated atony they are free from mucus, and are stained with blood only when the bowel is wounded during their evacuation. Intestinal stricture presents many points of resemblance, but can be differentiated whenever the form of the fecal mass and other palpable evidences of local constriction afford characteristic information.

Prognosis.—Intestinal atony does not particularly endanger life, but it is for many people a source of almost constant discomfort and inefficiency from early youth till the latest period of old age. Without the removal of its causes the disorder is incurable, and in too many cases these are irremediable.

Treatment.—The first thing to be formed is the habit of regular evacuation of the bowels. At a certain hour, preferably soon after a full meal, when the peristaltic action of the alimentary canal is thoroughly excited, the patient should attempt the act of defecation. This should be done without haste—sitting long at stool if need be—until the intestinal molimen is triumphantly aroused. Among the leisurely classes half an hour a day may be profitably consumed in this way, and its tedium may be eradicated by reading some cheerful book during the period of expectation. Copious draughts of water should be taken at intervals during each day, but iced drinks are to be avoided on account of their unfavorable effect upon the gastro-intestinal mucosa and musculature. Slothful habits must be exchanged for outdoor activity—walking, riding, bicycling, mountaineering. Diet should be so regulated as to include an abundant supply of vegetables and fruits. The late Dr. Byford was accustomed to prescribe for his constipated patients a ripe apple, to be eaten, skin, seeds, and core, before breakfast every morning. Honey, syrup, cream, and butter also have a gently laxative effect.

It is usually necessary to have recourse to the various laxatives that are useful in chronic intestinal catarrh. Chief among these may be mentioned the various preparations of cascara sagrada, pills containing aloin, strychnine, and belladonna, compound rhubarb pills, aloetic dinner pills, and occasionally a blue pill. In certain old and obstinate cases it is said that nothing but full doses of calomel will prove effectual. When complicated with the arthritic predisposition laxatives that contain sulphur—compound licorice powder, compound sulphur tablets, etc.—are to be preferred. A course of mineral waters usually gives at least temporary relief. Under all circumstances it is necessary to be supplied with numerous laxatives, so as to be able to furnish a fresh prescription when the old one has lost its effect.

INTESTINAL HEMORRHAGE.

Synonyms.—Enterorrhagia; Entero-hæmorrhagia; Darmblutung.

Etiology.—Hemorrhage from the intestines may occur from so many causes operating under such widely different conditions that it is advisable to consider as a whole the significance of this multifarious symptom. Thus examined, its causes may be classified under three general categories connected with abnormal states of the intestinal contents, or with pathological changes in the intestinal structure, or with general and infective diseases that predispose to hemorrhage in all parts of the body.

Slight bleeding from the intestinal mucosa frequently follows the evacuation of long-retained and hardened fæces. This usually occurs in the lower bowel, sometimes from a rupture of the mucous membrane during laborious defecation, sometimes from mechanical injuries during the passage of foreign bodies, fragments of bone, etc. that have been swallowed. In certain cases hemorrhage is the direct result of injury caused by a sort of impalement with various articles thrust violently through the anus into the rectum. Insane people thus injure themselves, sometimes with bottles, inkstands, pieces of wood, or anything else that happens to excite their fancy. Bleeding may also occur after the ingestion of caustic and corrosive poisons, or even after excessive doses of ordinary purgative remedies. The presence in the intestine of certain parasites, notably Anchylostomum duodenale and Distomum hæmatobium, causes persistent and dangerous hemorrhage through laceration of the intestinal wall by their teeth.

Among the local causes that implicate the intestinal structure traumatic lesions have been already mentioned. Ulceration of the bowels is, however, the most common local cause of bleeding. Since ulceration is one of the most frequent events in diseases of the intestines, while hemorrhage is a comparatively rare occurrence, it is interesting to note the protective influence of the thrombi that form in the adjacent blood-vessels during the course of the ulcerative process. Inflammation of the mucosa is often attended with bleeding that, though usually inconsiderable, may, especially among elderly patients, assume formidable proportions. Somewhat similar in nature are the inflammation, ulceration, and hemorrhage that sometimes occur in the small intestine as a consequence of extensive burns or scalds involving the cutaneous surface of the body. Intussusception of the bowel is usually accompanied by continuous oozing of blood from the strangulated vessels in the invaginated portion of the intestine. A quite analogous discharge takes place whenever the blood circulation in the portal system is obstructed either by reason of local disorder within the abdomen or by general causes operating upon the heart and lympho-cruoral circulatory apparatus. In this way hemorrhage from the bowels may result from cardiac disease or from pulmonary resistance to the passage of blood from the right ventricle to the left auricle. Amyloid disease of the bloodvessels has been known to originate the symptom; and it is not an uncommon event to witness hemorrhage in diseases of the liver and portal vein that encroach upon the capacity of the hepatic and portal vessels. In like manner embolic obstruction of the mesenteric arteries or the rupture

into the intestine of an intra-abdominal aneurysm may cause a discharge of blood through the bowels.

The various infective diseases are frequent causes of intestinal hemorrhage, either by reason of the ulceration which they excite in the mucosa or through the general dyscrasia which results from the action of their infections and toxins upon the tissues. Thus, syphilis, dysentery, and typhoid fever produce hemorrhage, usually as the result of ulceration. In many instances of early bleeding from the nose and intestines in typhoid fever, before intestinal ulceration has occurred, the incident must be ascribed to the general dyscrasia of the blood. This undoubtedly is the cause of the hemorrhages sometimes observed in desperate cases of cholera, and so frequently in yellow fever, plague, pyæmia, septicæmia, and malarial fever. It is doubtful whether Frerichs' ascription of malarial hemorrhages to clogging of the liver with melanin is correct, though excessive deposits of this substance may result from the same causes that determine the hepatic obstruction. In scurvy, purpura, hæmophilia, uræmia, and cholæmia hemorrhage should be regarded as a consequence of the various causes that have affected the nutrition of the vascular apparatus as well as of the blood.

Vicarious hemorrhage from the alimentary canal is sometimes witnessed when the menses are suppressed. In such cases blood is discharged from the stomach more frequently than from the bowels—the reverse of what takes place when from any cause the male sex exhibits the symptom.

Pathological Anatomy.—On examination of the intestinal mucosa after death ulcerated surfaces, with still open vessels from which blood has been recently discharged, can be often discovered. In other cases naught but the evidences of capillary oozing can be demonstrated. Sometimes, as in typhoid fever, both conditions coexist. It is probable that the hemorrhage in the majority of typhoid fever cases is from the capillaries rather than from larger vessels.

The whole length of the bowel is sometimes filled with blood, even in cases where there has been no discharge of blood through the anus before death. In some cases the effused liquid has undergone coagulation; sometimes it remains permanently fluid through the absence of the constituents of fibrin. Sometimes the coagula are condensed into hard and carbonaceous masses like coproliths. In other instances the disorganized blood exhibits a brownish flocculent appearance, like the grounds of beef tea; sometimes it is tarry in color and consistence and exhales an offensive odor. In many instances the quantity of blood is small, and it is diluted with a considerable amount of serous exudation, to which it gives the appearance of water in which raw meat has been washed, and in which pus and mucus can be discovered.

Any considerable loss of blood is followed by a pallid appearance of the abdominal organs. When hemorrhage is long continued or frequently repeated the internal viscera and the glandular structures in the gastro-intestinal wall undergo fatty degeneration as a consequence of the deficient amount of oxygen that is furnished to them by the impoverished blood.

Symptoms.—Intestinal hemorrhage sometimes remains concealed, so far as any external appearance of blood is concerned. The patient

passes more or less rapidly into a condition of collapse, with all the symptoms that are characteristic of excessive bleeding, and may die without any discharge of blood from the anus. Sometimes, however, the accumulation of blood in the intestine is so large that the abdomen is dull on percussion, and may be actually distended to a considerable degree.

But in by far the majority of cases the fact of intestinal hemorrhage is proved by the evacuation of bloody stools. The color and consistence of these depend upon the place and the manner of their formation. As a general rule, the higher their origin the blacker their color. When formed in the upper part of the small intestine the discharges are black and tarry; when the bleeding occurs in the colon the principal portion of the stool may consist of fecal matter smeared with blood and slime. Sometimes the blood is retained long enough to become dried into hardened coprolithic masses that look like rounded fragments of coal. In dysenteric hemorrhages the blood is mixed with serous liquids, so as to resemble water in which raw beef has been washed, or it may be associated with large quantities of mucus, or, in chronic cases, with pus and slime. Hemorrhage that is caused by the growth of intestinal polypi is usually of a bright red color, and is accompanied by a considerable discharge of intestinal mucus.

Microscopical examination reveals blood-corpuscles in every stage of decomposition. Nothnagel and others, viewing the stools of typhoid fever patients, have discovered microscopical quantities of blood present even as long as thirty-six hours before the actual occurrence of visible hemorrhage.

Intestinal hemorrhage is sometimes attended with violent tenesmus and retention of fæces. E. Ingals has reported a case of this character in which the administration of a large dose of castor oil was followed by the evacuation of a potful of hardened fæces, with immediate relief from all the previous untoward symptoms. When hemorrhage occurs from the upper portion of the duodenum, blood may regurgitate into the stomach and be evacuated by the act of vomiting.

Palpation of the abdomen must be, in all cases of intestinal hemorrhage, conducted with great caution, for in many instances even the slightest movement of the body is at once followed by an increased flow of blood. When the case becomes persistent for some time, œdema and transient albuminuria may appear, just as in any other form of acute anæmia.

Diagnosis.—In every case of reported hemorrhage from the bowels it is necessary first to ascertain the actual presence of blood in the stools. This is important, because the dark, slaty-colored masses that are sometimes voided during the course of obstinate constipation may be mistaken by an inexperienced observer for altered blood. The same thing is true of the dark green, intensely bilious stools that are sometimes discharged when the liver overflows with bile. Nor may it be forgotten that the administration of iron or bismuth will color the fæces with the black sulphides of those metals, causing the stools to appear very much like the black and tarry discharges caused by hemorrhage from the upper portion of the small intestine. Various fruits and other vegetable coloring matters, such as raspberries, red currants, red wine, and hæma-

toxylin, may impart a suspiciously bloody color to the intestinal contents. But careful mixture of the fæces with water, which, if blood be present, is speedily colored with hæmoglobin, or in still more doubtful cases the use of the microscope and spectroscope, will soon decide the question as to the presence or absence of blood from the stools.

Having determined the fact of a hemorrhagic discharge from the anus, it is necessary to ascertain the source of the blood, since it may have reached the intestines from the mouth, nose, pharynx, larynx, lungs, œsophagus, or stomach. The blood may have been swallowed by a malingerer or by a newborn infant during the act of parturition or by a nursling whose mother's nipples were in a bleeding condition. All these possibilities should be passed in review.

As to the location of the hemorrhage, some difficulty may arise. It is almost if not quite impossible to distinguish between discharges of blood from the stomach and from the duodenum. Hemorrhages from the small intestine are usually darker than those from the lower bowel, and they are either of purer blood or are more thoroughly incorporated with the intestinal contents than when their origin is in the large intestine. Examination of the rectum sometimes discovers the source in wounded hemorrhoidal veins or rectal ulcers or polypi of the lower portion of the mucosa. In typhoid fever bleeding is usually from the small intestine, while in dysentery it is from the colon or rectum. In chronic colitis it appears upon the external surfaces of the fecal cylinder, instead of being homogeneously mixed with the stools.

The cause of intestinal hemorrhage can be determined only by reference to the past history and present condition of the patient. The incidence of sudden collapse in typhoid fever, in the absence of other causes, should always awaken the suspicion of latent bleeding from the intestinal wall.

Prognosis.—In all cases of intestinal hemorrhage the outcome depends upon the cause and the extent of the loss of blood. In carcinoma of the bowels and in tuberculosis, or in extensive ulceration of the intestines, hemorrhage may rapidly lead to a fatal result. But in typhoid fever, when moderate bleeding occurs at an early stage of the disease, it often produces a salutary result, like what is often witnessed after simple epistaxis. If, however, the hemorrhage occurs after the formation of deep ulcers, or if it is copious and persistent, it is a most formidable symptom of danger.

Treatment.—The diet should be a matter of prime consideration in cases of ulcerated bowel, for coarse food may by local irritation of a deep ulcer excite a hemorrhage. When bleeding has begun the patient should be placed in bed, with the foot of the bedstead sufficiently elevated to favor the flow of blood into the head and upper portion of the body. Only milk, ice, and cold drinks should be allowed. An ice-bag or a coil of cold water should be laid over the abdomen, as near as possible to the point of hemorrhage. The movements of the bowels should be restrained with sufficient doses of opium. Five drops of the liquor ferri pernitratis or persulphatis may be given in half a tumbler of water every two hours. Gallic acid, five grains every four hours, is very efficient. Ergotol, or the aqueous extract of ergot, may be injected hypodermically in full doses every six hours.

When the seat of hemorrhage is in the colon or rectum considerable benefit may be obtained from the use of astringent injections, such as tannic acid, one grain to the ounce of ice water, or a quarter of a grain of nitrate of silver to the ounce of water.

Hemorrhages that accompany malarial infection require large doses of quinine in addition to the ordinary treatment.

If collapse be imminent, alcohol may be given in moderate doses if there be evidence of arterial constriction in any portion of the body or extremities. The heart should be aided with camphor, musk, and capsicum:

℞. Moschi,
Pulveris camphoræ,
Pulveris capsici, āā. gr. j;
Fiat pilula No. j.
Sig. Give one such pill every two to four hours.

In desperate cases recourse should be had to the hypodermic injection of one grain of camphor dissolved in ten parts of olive oil. Transfusion of blood under such circumstances does not give a favorable result, for with a renewed supply of blood a renewal of bleeding occurs.

INTESTINAL CANCER.

Synonyms.—Carcinoma of the bowels; Carcinoma intestinale; Darmkrebs.

Cancer of the intestine occurs usually as a primary disease of the affected part. Its favorite seat is at the junction of the rectum with the sigmoid flexure of the colon. Next in order of preference ranks the sigmoid flexure itself; then follows the head of the colon, including the ileo-cæcal valve and the point of union between the cæcum and the ileum. Beyond this point the small intestine usually escapes until the gastro-duodenal portion is reached, where the parts adjacent to the orifice of the common bile duct and the entrance of the pylorus are comparatively often involved. Various mechanical explanations of this distribution have been offered, but none of them are satisfactory. According to Leube, 80 per cent. of intestinal cancers are found in the portion below the sigmoid flexure, while only 5 per cent. invade the small intestine. In the rectum colloid cancer is most common, though pigment cancers are sometimes found in that region. As in the stomach, so throughout the alimentary canal, carcinomatous growths assume the characteristics of scirrhous, encephaloid, and colloid cancer, so that the general appearance of the neoplasm corresponds to its histological structure, precisely as in similar growths within the gastric wall. In the intestine, however, there is a marked tendency to concentric invasion of the entire circumference of the bowel, so that the occurrence of stricture and occlusion of the canal are common events. Less frequently does the neoplasm develop as an isolated tumor projecting into the lumen of the gut. Occasionally, the cancerous invasion simultane-

ously occupies distant segments of the alimentary canal, instead of being concentrated upon a single division.

Intestinal carcinoma is usually composed of cylinder epithelial elements, except in the lower part of the rectum, where the pavement epithelial cells predominate. It would therefore appear that the development of intestinal cancer originates, as in the stomach, from the glandular structures of the mucosa. The submucosa and the muscular coat may be subsequently invaded, and even the peritoneal investment may be finally involved.

When constricted by cancerous infiltration the portion of the intestine that lies above the stricture becomes dilated and filled with more or less stagnant fæces. The mucous membrane exhibits evidence of chronic inflammation, erosion, and ulceration; and sometimes actual rupture of the bowel may occur. Below the stricture the intestine collapses and falls into a condition of atrophy. When the neoplasm is of an encephaloid character the stricture may be occasionally relieved by sloughing and evacuation of the obstructive portion of the growth. Such processes may be followed by an imperfect cicatrization; but, like all cicatricial tissue, these scars exhibit a tendency to contraction, by which stenosis may be again established. In many instances, however, there is no time for healing; the breaking down of the diseased mass is followed by alarming hemorrhage or by actual perforation of the intestinal wall, opening a communication between the alimentary canal and the cavity of the peritoneum or of the uterus, vagina, bladder, stomach, or even through the abdominal wall into the external world. Fecal abscesses may be thus originated behind the peritoneum. The lymph glands and still more remote organs, like the liver and the pelvic viscera, may be invaded by a process of secondary cancerous infiltration.

Etiology.—Intestinal cancer occurs more frequently among men than among women, and it usually appears after the fortieth year of life. A few cases, however, have been reported among children even as early as the first few days after birth. An occasional connection between the scars of ulceration and subsequent cancerous growth has been remarked. But as to the real course of malignant new growths in the intestinal canal we are still quite ignorant.

Symptoms.—Intestinal cancer may run its whole course without any decisive or conspicuous symptoms. Not infrequently there may be experience of abdominal pain, irregular action of the bowels, alternate constipation and diarrhœa, progressive emaciation, increasing exhaustion, and, finally, death without any clearly apparent cause—a train of symptoms that only find their explanation in the post-mortem discovery of malignant disease of the bowels. Sometimes the first notable indication of disease consists in the sudden occurrence of intestinal occlusion through the lodgement of undigested masses of food above an annular cancer. Such an event should be suspected when in an elderly subject sudden obstruction of the bowels is developed without any evident reason. In like manner, the manifestations of chronic peritonitis may be sometimes traced to a latent intestinal carcinoma. When the lower portion of the colon and the rectum are invaded an atrocious pain is experienced beneath the sacrum, radiating into the sexual organs and along the nerves that emerge from the pelvis, so that by an incautious observer

sciatica might be suspected. Only when an intra-abdominal tumor connected with the bowels can be demonstrated is it easy to recognize the actual existence of an intestinal neoplasm. But when a tumor is manifest, and when the fæces exhibit characteristic changes, the recognition of the disease is not difficult. Investigation of the abdominal contents may be effected by external palpation, by rectal examination, in females by vaginal exploration, and by a combination of all these methods. When it is possible by palpation through the abdominal walls to recognize the presence of a tumor, an irregularly oval or rounded mass will be discovered, usually below the level of the umbilicus when connected with the movable portions of the intestine, because under such conditions it is more easily borne downward by its own weight; but if located in the ileo-cæcal region or if held fast by inflammatory adhesions, it will remain fixed in the same portion. Such tumors are usually quite sensitive to pressure, and cannot be moulded by the fingers like the fecal scybala which sometimes linger in the intestinal canal. When intestinal stenosis has been established the dimensions of the tumor frequently undergo very rapid and considerable variation, often in a few hours changing form and size to an astonishing degree, sometimes even disappearing completely for several successive days. These alterations are due to the filling and emptying of the intestinal pouch that forms above the obstructive tumor. The percussion note that is procured by percussion over such masses is a dull, tympanitic, muffled resonance, such as might be expected from a putty-like substance lying amidst coils of more or less air-filled intestine.

When the rectum is the seat of carcinoma exploration should be performed with the finger through the anus, because instrumental examination with specula is exceedingly difficult and painful. It is comparatively easy with the finger to detect stenosis or ulceration of the gut; and the uneven, slimy, and bloody surfaces of such a tumor can be readily investigated. In the same way fragments of broken-down and decomposing tissue can be obtained for inspection, olfaction, and microscopical examination. Sometimes when straining at stool a prolapse of the infiltrated rectal wall takes place, so that a portion of the cancerous mass becomes actually visible outside of the anus. When the neoplasm is situated higher up, beyond the reach of the finger, it may be frequently explored with the aid of a rectal sound, and in some cases valuable information may be obtained by an attempt to introduce water into the bowel with a fountain syringe, noting the degree and distance of the obstruction thus encountered.

Obstinate constipation is the rule in the majority of cases. When the bowel is merely strictured the fæces may be flattened or be voided in small lumpy masses, like the dung of sheep. But in certain cases there is complete occlusion of the bowels. This may persist for many days, sometimes for weeks, and may occasionally yield suddenly, either through the giving way of the degenerated obstructive mass or through ulceration and perforation occurring between two adjacent loops of intestine that have become adherent through inflammation above and below the tumor. Severe hemorrhage sometimes follows the breaking down of the softened substance of the new growth, especially when it is of the encephaloid variety.

Special symptoms are often due to the particular location of the carcinoma. Thus, when the duodenum is invaded persistent jaundice may accompany the progressive emaciation and cachexia by reason of compression of the common bile duct. If the pyloric region be encroached upon, the vomiting and dilatation of the stomach that depend upon pyloric stenosis may occur.

When the lower extremity of the small intestine is the seat of cancerous stenosis there may be only rational signs to guide the diagnosis until the phenomena of fecal vomiting and intestinal occlusion appear.

When located in the rectum a cancerous growth may exist for a considerable time without serious interference with the general health. But the evacuation of the bowels is almost always attended with such pain that the sufferer delays as long as possible their movement. Frequently there is a troublesome diarrhœa, with distressing tenesmus and prolapse even of the mucous lining of the rectum. A foul, ichorous, and irritating discharge, mixed with pus, blood, and minute fragments of broken-down tissue, is not uncommon. The hemorrhoidal veins are frequently enlarged, and the resulting tumefaction must not be mistaken for cancerous growth.

The DURATION of intestinal cancer is about four years. Its normal course is free from fever, but sometimes there may occur a paroxysm or period of fever that is due to a local process of inflammation in any or all of the tissues adjacent to the neoplasm; or it may be the result of general auto-infection from the diseased territory; or it may originate in the actual passage of broken-down cancerous and septic matter into the general circulation of the body.

Death frequently occurs through simple starvation and exhaustion of the tissues. The limbs become œdematous; thrombi may obstruct the veins and send emboli into the capillaries of the lungs with a fatal result. In certain cases death is preceded by coma from thrombosis in the cerebral sinuses and meningeal veins; in other instances it is the result of a species of auto-intoxication, with an abundance of acetone and diacetic acid in the urine. Indican is usually present in the urine, as in other forms of marasmus accompanied by gastro-intestinal auto-intoxication. Sometimes death occurs rather as the result of secondary cancerous invasion of the liver or other important organs. Intestinal occlusion, and invagination of the bowel as a consequence, may directly lead to death. Perforation of the bowel through ulceration or rupture, and peritonitis that may be either local or generally diffused, are not uncommon causes of death. Such perforations may lead to the formation of fecal abscesses and pyæmia, or they may open a communication between the intestine and any one of the hollow organs in the abdominal or pelvic cavities, thus hastening the fatal termination.

DIAGNOSIS AND PROGNOSIS.—The diagnosis of intestinal cancer is often attended with great difficulty. Annular invasion of the intestinal walls may take place without the production of any appreciable tumor. When by palpation of the abdomen the presence of a tumor has been recognized, it is often impossible to determine its exact connections, whether it be a neoplasm involving the pylorus, the liver, the pancreas, the kidneys, the mesentery, or the abdominal lymph glands. Sometimes an encapsulated peritonitis may simulate a carcinomatous mass,

and an enormous gall-stone that has ulcerated its way into the intestine may be in like manner mistaken for a small occluding tumor of cancerous nature. The obstinate constipation and final cessation of intestinal defecation that are often experienced are not infallible indications of cancerous growth, for the bowels may be occasionally compressed and closed by the pressure of tumors that have been formed entirely outside of the alimentary canal. Enteroptosis, by reason of the increasing weight of a growing tumor, may also serve to embarrass the localizing diagnosis of the disease, since the abdominal viscera are often dragged out of place by the enlargement of such neoplasms. It is only when the cancerous mass is situated in the rectum or about the sigmoid flexure of the colon that its recognition and situation are rendered easy. The occurrence of constipation, tenesmus, and painful discharges of blood, mucus, and pus should lead the physician to make a thorough examination of the rectum and lower portion of the colon. The prognosis is uniformly bad.

Treatment.—Active treatment of intestinal cancer falls within the territory of surgery rather than of medicine. Occlusion of the bowels may be relieved by operative measures for the establishment of an artificial anus. This method is most successful when the large intestine is the seat of obstruction, because an opening into the small intestine interferes to such an extent with digestion and absorption of aliment that death from starvation usually follows the operation. Cancers of the rectum have been resected, scraped, cauterized, and otherwise subjected to the most elaborate surgical treatment, but with only one result—miserable death, even after apparent temporary relief of certain minor symptoms.

When the symptoms of intestinal stenosis begin to manifest themselves the diet should be so regulated as to exclude starchy substances that increase the fæces, and should be made to consist chiefly of milk, eggs, soups, broths, and animal substances that contain comparatively little residual matter. Gentle laxatives should be directed against constipation, and the bowels should be often flushed with copious clysters of warm salt water (a drachm of table-salt to the pint). If the rectum and colon are the seat of the disease, appropriate disinfectants, such as potassium permanganate, in a 1 per cent. solution, or half an ounce of liq. aluminii acetat. to a pint, should be added to the water. The hypodermic exhibition of morphine and atropine is often demanded by reason of severe abdominal pain. Tenesmus and rectal pain may be counteracted by the introduction, at bedtime, of a rectal suppository containing one third of a grain of morphine sulphate with one eightieth of a grain of atropine, incorporated in a sufficient quantity of cocoa butter.

SARCOMA OF THE INTESTINES; OTHER TUMORS.

Sarcoma of the intestines is a rare disease, and during the life of the patient it cannot be accurately differentiated from ordinary carcinomatous neoplasms. The tumors spring from the submucosa, and may be

of either primary or secondary origin. They usually increase more rapidly than cancerous growths, and speedily involve other organs. Rarely do they cause intestinal stenosis, but more frequently do they lead to paralytic dilatation of the bowel and to consequent stagnation of fæces.

Lipoma, angioma, lymphangioma, myoma, and cystoma are occasionally encountered upon the dissecting table, but they need be mentioned only as pathological curiosities.

INTESTINAL POLYPI.

Intestinal polypi sometimes are of a fibromatous character, springing from the submucous tissues. Sometimes, however, they are of mucous origin, and are connected with an overgrowth of the mucous glandular substance. Their favorite seat is in the rectum, where they may exist as solitary or multiple tumors. Most frequently they are met with among children who have suffered with worms or with gastro-intestinal catarrh. They are often accompanied by a diarrhœa with bloody and slimy stools—in fact, the occurrence of such a diarrhœa in a child should lead to a careful examination of the rectum. Sometimes the tumor prolapses and makes its appearance through the anus when the patient is at stool. Sometimes it becomes detached from its slender pedicle and is discharged with the fæces. In certain cases the fecal cylinder exhibits upon its side a furrow ploughed by its passage over the mass. When intestinal polypi reach a considerable size they may by their weight cause intestinal invagination with prolapse of a portion of the bowel. Occasionally the existence of a polypous mass gives rise to the symptoms of intestinal occlusion, with subsequent relief when the tumor breaks loose and is discharged.

Tuberculosis of the Intestine is described in Vol. I. pp. 813–816.
Syphilis of the Intestine is described in Vol. I. pp. 872, 880, 881.
Dysentery is described in Vol. I. pp. 339–389.
Diphtheritic Dysentery is described in Vol. I. pp. 349–351.

INTUSSUSCEPTION OF THE BOWELS.

Synonyms.—Intussusceptio; Invaginatio; Darmeinschiebung.

Definition.—Intussusception consists in the entrance of one portion of the intestine within another by an infolding of the bowel, so that the external fold ensheaths the inner. This condition is not infrequently discovered upon the post-mortem table as a result of the increased peristalsis that is caused by the arrest of circulation that accompanies death, but in such cases there are no pathological conditions to account for the incident, nor are there any signs of adhesion or strangu-

lation of the walls of the gut. It is usually the small intestine that is the seat of these irregular manifestations of peristaltic action. The direction of the movement may be either upward or downward.

But when true intussusception occurs during life the intrusory movement is almost always from above downward—the upper segment is received within the lower. The invaginated portion is therefore surrounded by a double sheath consisting of the infolded portion of the lower segment and of the external part of the still unfolded intestine that surrounds the entire mass and forms its sheath. Besides the intussuscepted portion the sheath also contains the mesenteric leaf that is attached to the mesenteric seam of the intestine. By the traction of this membrane the lower orifice of the invaginated segment of the bowel is drawn upward, so that it assumes the form of a longitudinal slit rather than that of a circular opening. The line where the upper opening of the sheath grips the intussuscept is called the neck of the invagination. Here inflammation is rapidly established, and by the swelling thus occasioned strangulation of the ensheathed portion of the bowel is considerably aggravated. The process of invagination may be initiated by the down-dragging weight of a tumor that is attached to the inner surface of the intestine; or there may be a paralytic dilatation of the intestinal tube that permits the intrusion of the adjoining segment in which peristaltic contraction is still active. Under either circumstance the process, once started, is maintained and aggravated by a spasmodic condition of the intestinal muscles in the neck of the sheath, and by the weight of the tumor, if there be one, or of the column of fæces that forms by accumulation above the constriction. The upper segment of the intestine is thus urged on deeper and deeper into the sheath, which is proportionately lengthened at the expense of the lower segment. In this way the colon may swallow its upper portion, together with a great length of the ileum, until the colonic coil is effaced, leaving only a straight tube that spans the abdomen from one iliac fossa to the other. In this way the intussuscept may reach the anus and project for several inches externally to that opening. Sometimes, by a process of adhesive inflammation at the neck of the sheath, so great a degree of strangulation may be effected that the invaginated portion sloughs off, and is discharged through the rectum in the course of a sort of natural healing process. But under the most favorable conditions there must be danger of hemorrhage during the separation of the gangrenous parts, or of general peritonitis or septic poisoning. Should cicatrization be successfully accomplished, there would still be danger of subsequent contraction and stenosis at the site of the scar. In such case coprostasis, great distention of the intestines with gas, and upward pressure of the diaphragm against the heart and lungs would occur.

It occasionally happens that only partial invagination of one side of the intestinal wall takes place. This incomplete intussusception usually occurs when the weight of a tumor dragging the inner surface of the intestine causes a portion of the parietes to sink downward into the lumen of the bowel. In such cases there is always the probability that a partial intussusception may be finally converted into a complete descent of the gut.

Intussusception may be effected in any portion of the intestinal

canal, but it is most common at the ileo-cæcal junction. Here the ileum descends into the colon, sometimes drawing after itself the vermiform appendix and the upper portion of the large intestine. According to the statistics collected by Brinton and Leichtenstern, invagination occurs with the following frequency:

	Brinton.	Lichtenstern.
Ileo-cæcal invagination	56 per cent.	44 per cent.
Ileo-colonic "		8 "
Iliac "	28 "	30 "
Jejunal "	4 "	
Colonic "	12 "	18 "
	100 per cent.	100 per cent.

Etiology.—Allusion has been already made to certain causes of intussusception, such as segmental atony of certain portions of the intestine and the downward and inward traction of polypoid tumors upon the inner surface of the bowel. Occasionally it has been witnessed in connection with cancerous growths involving the wall of the alimentary canal. It is not uncommonly connected with chronic catarrhal conditions of the mucosa; hence it may occur after obstinate constipation or as a consequence of chronic diarrhœa after dysentery or typhoid fever. It has been experienced after blows or falls or other violence to the abdominal viscera. It is especially among children that it is encountered; perhaps more frequently among boys than among girls. Fully half of the cases are experienced during the first year of life, and of this half about two thirds occur between the fourth and sixth months of infancy—an age when intestinal disorders are frequent, and when irregular and spasmodic contractions of the muscular coats of the alimentary canal are easily provoked.

Symptoms.—Intussusception is usually indicated by the sudden incidence of paroxysmal pain within the abdomen. So severe is this that among young children, who form so large a proportion of its victims, the attack is ushered in with loud crying, or even with convulsions, as in the worst forms of colic. So close is the similarity that the seat of the pain, which is usually around the navel, affords no guide to the exact location of the disease. The stools often become thin, slimy, and bloody. The blood, which is sometimes almost wholly free from admixture with other substances, exudes from the mucous surface of the invaginated and strangulated portion of the intestine. When the lower portion of the colon and the rectum are involved, either by actual intussusception or by pressure from above, frequent tenesmus is experienced. When there is complete obstruction of the bowel or when its upper segments are involved, there may be continued vomiting. At first the abdomen may be somewhat flaccid and not particularly sensitive to pressure, but usually it soon becomes greatly distended and intolerant of manipulation. Since the ileo-cæcal portion of the intestine is the most common seat of invagination, it is not an uncommon event to discover a smooth, elastic, and sausage-like tumor in the right iliac fossa, extending toward or beyond the umbilicus. Frequently attention is arrested by a constantly patulous state of the anus, from which opening trickles a slender stream of blood and slime. The finger may then be readily passed into the rectum, where sometimes the descending

mass of strangulated intestine can be easily reached, and the abolition of all wrinkling and folding of the rectal mucosa under the influence of downward pressure can be accurately noted.

If the invaginated portion of the intestine should descend through the anus, it may be recognized as a red, slimy, and cylindrical mass, covered with bloody mucus that oozes from the swollen surface. Sometimes the tumor recedes and disappears by spontaneous reduction, after which the gaseous and fecal contents of the upper intestine resume their normal course, and rapid convalescence takes place. Relapses, however, are not uncommon. But in many instances, instead of improvement, the severity of the symptoms increases ; the bowels become completely occluded, giving rise to the phenomena of intestinal obstruction ; the belly is swelled, tense, and painful, with all the usual manifestations of peritonitis ; and the patient sinks into a state of collapse, followed by death. In young children this event is often preceded by muscular spasms and convulsions dependent upon cerebral anæmia and progressive exhaustion.

Occasionally the strangulated segment of the intestine becomes gangrenous, and is sloughed off at the neck of the tumor, where an adhesive inflammation has united the remaining segments of the sheath and of the upper intestine. This process of spontaneous cure takes place usually between the middle of the second week and the end of the third in the course of the disease. Sometimes the dead mass comes away piecemeal, but in other cases the whole is thrown off at once. Cruveilhier reports a case in which not less than ten feet of the bowel were thus discharged. Unfortunately, recovery does not always follow the relief that is thus obtained. Fatal hemorrhage, perforation of the intestine, peritonitis, septicæmia, thrombosis of the mesenteric veins, hepatic and pulmonary abscesses may develop and destroy life ; or, if all these dangers should be evaded, the contraction of the scar at the line of union may yet produce stenosis of the bowel with all its lethal consequences.

The duration and the severity of the symptoms of intussusception depend upon the extent of the invagination and the completeness of intestinal occlusion. In the worst cases death, preceded by shock, may occur within a few hours. Severe cases may continue for a week, and those of moderate intensity may last for a month before reaching a fatal termination or recovery. Incomplete cases, in which the bowel still permits some passage of fæces, have been known to endure for many months or even for a whole year.

Diagnosis.—The difficulties of diagnosis are not usually very great. The disease may be recognized by a consideration of the symptoms, especially when in the abdomen of an infant a firm longitudinal tumor makes its appearance, or when from the gaping anus a bloody slime continually trickles. But it must not be forgotten that a similar condition of the rectum and anus may be induced by the descent of a large polypus. And in cases where peritonitis has originated at an early period the existence of an invaginated mass may be concealed by the general swelling and painful condition of the abdominal contents. Very similar conditions are also present in cases of twisting and knotting of the intestines.

PROGNOSIS.—The death-rate in cases of intussusception is very high —about 70 per cent. The chances of recovery are greater when there is not complete occlusion of the intestine and when peritonitis has not occurred. When sloughing and discharge of the intussuscept takes place the mortality is less, though still very large, being about 41 per cent.

TREATMENT.—The first thing to be attempted in the treatment of intussusception is to arrest the peristaltic movement of the intestine. This should be effected by the frequent administration of opiates in small doses until the pupils are contracted. To a grown person may be given half a grain of opium every hour till the effect is produced. To children should be administered the deodorized tincture in doses of one to five drops according to the age of the patient. The colon should be slowly distended several times a day with warm water from a fountain syringe. But after the case has progressed for several days this operation must be performed with great caution for fear of rupturing the weakened bowel. For the same reason inflation of the bowel with air from a bellows, or by the liberation of carbonic acid gas above the sigmoid flexure, is not a very commendable operation. All these methods of procedure are more likely to be successful if conducted while the patient is under the influence of ether or chloroform. The hips should be greatly elevated—in fact, young children can be with advantage momentarily suspended by the legs, when sometimes the bowel replaces itself with an audible gurgle, followed by the escape of gas and fæces from the anus. When the invagination implicates the lower portion of the colon, so that it can be reached through the rectum, an attempt may be made to replace the mass by pressure upward with a well-oiled rectal bougie. The patient, if old enough to be manageable, should be placed in the knee-elbow position—arms folded under the chest and the pelvis reared up as high as possible—when the admission of air into the rectum will greatly aid the force of gravity in producing the return of the intussuscept to its normal place. It must be admitted, however, that relapses are not infrequent.

When other methods have failed the question of laparotomy arises for consideration. This should be attempted before the incidence of peritonitis. Herz reports 30 per cent. of recoveries among 20 cases subjected to operation. Treves reports a mortality of 72 per cent. in 133 cases of surgical interference. He adds the statement that when reduction was easily performed the mortality was 30 per cent., but when difficult it was 91 per cent.

CONSTRICTION AND OCCLUSION OF THE INTESTINES.

SYNONYMS.—Enterostenosis et ileus; Darmverengerung und Darmverschluss.

ETIOLOGY.—The various processes by which intestinal stenosis and occlusion are affected have much that is common in their causes and symptoms. The same causes that produce constriction of the bowel

may finally lead to its complete closure. These conditions usually originate in the intestinal wall, in the intestinal contents, or in neighboring organs of the body. Thus the growth of tumors of a cancerous or polypoid character in or upon the wall of the intestine, or the contraction and induration of cicatricial tissue in the same locality, may obstruct and finally close the passage. In the same way the rectum may be narrowed by the growth of hemorrhoids or syphilitic indurations. Sometimes occlusion is effected by twisting of the gut, or by intussusception, or by the occurrence of internal hernia, as when an intestinal loop slips through an abnormal opening in the mesentery, or the suspensory ligament of the liver, or a broad ligament of the uterus. Strangulation in the foramen of Winslow has been known to occur, as well as in all the other forms of internal hernia that may result from congenital or acquired defects of structure. In like manner inflammation of the peritoneum may cause stenosis or occlusion, either directly by paralysis of the intestinal wall or by plastic effusion that compresses the bowel and constricts its lumen. In this way may be produced bridles of organized lymph bands of adhesion, by which the intestine may be gripped long after the subsidence of the original disturbance.

Obstruction of the intestine is sometimes caused by local paralysis of its muscular layer at some point where it has been exposed to injury by a blow upon the external surface of the abdomen, or by peritoneal inflammation after the reduction of a hernia, or by a laparotomy. Obstinate constipation amounting to occlusion is sometimes experienced as a consequence of more general paralysis due to cerebral and spinal diseases.

The condition of the contents of the bowel is sometimes such as to close the lumen of the tube. In one of my own cases an old coprostasis sealed the intestines until, after much urging with large injections of hot water, forty-three coproliths passed the anus. Huge gall stones occasionally ulcerate their way into the small intestine, where they produce stenosis or, in rare instances, complete occlusion. Among children and childish adults the bowels are sometimes filled up with the large seeds of grapes, pomegranates, cherries, and their like. Eichhorst has recorded a case where a man with an occluded rectum, confessing to having eaten a "few cherries," was relieved only after one thousand and ten cherry-pits had been scooped out of his rectum. In like manner, almost everything of a solid character that can be swallowed has been known to obstruct the alimentary canal. Sometimes a considerable number of round-worms may lodge in the intestine. I once saw a ball of these lumbricoid parasites as large as a lemon that had been voided by a child of five years after several days of suffering from intestinal occlusion.

The intestine is sometimes compressed and may be completely occluded by the growth of all sorts of tumors in the adjacent organs. Inflammatory exudations or hemorrhagic effusions within the cavities of the abdomen or pelvis may exert a similar pressure. Cancerous growths in the mesentery or in the liver, stomach, pancreas, kidneys, uterus, ovaries, and bladder may produce the same result. Tubal pregnancy has also been known to effect the same consequences. In at least one instance a floating kidney has been known to descend upon the sigmoid

flexure of the colon, developing continued symptoms of obstruction that, until the death of the patient, were ascribed to malignant disease.

Intestinal obstruction is less frequent among females than among males, and with them it is usually due to pelvic and peritoneal inflammations, connected with pregnancy and parturition. Among males it is the laboring class that furnishes the largest contingent of sufferers. Children are, more than adults, liable to obstruction by invagination, while adults more frequently experience the forms due to coprostasis and the arrest of gall stones. Among the Russians, who are said to be gifted with an extraordinary length of intestine, the bowels are frequently stopped by twisting or knotting of the gut.

Statistics vary considerably regarding the incidence of this disease. Leichtenstern estimates that in Germany there is 1 death from occlusion out of every 300 to 500 from all other causes. Fagge reports 1.4 per cent. of the deaths in Guy's Hospital during fifteen consecutive years as occasioned by intestinal obstruction. But Eichhorst, at the Zürich clinic, among 12,073 medical patients could discover only 4 who were suffering in this way.

Pathological Anatomy.—Wherever the bowel is constricted or occluded the portion above the point of constriction becomes dilated with fæces and gas, so that the intestinal coils are greatly exaggerated and uncommonly prominent. If the seat of obstruction is in the duodenum, the stomach participates in the dilatation. Below the site of constriction the intestine remains empty and collapsed. When stoppage of the bowel occurs suddenly, the intestinal wall soon undergoes atrophy, growing thin and pale; but if obstruction be slowly developed, as when caused by the contraction of cicatricial tissue or by the growth of a parietal tumor, the muscular coat of the intestine becomes hypertrophied through compensatory hyperplasia of the muscular tissue. Experiments upon animals show that such hyperplasia does not take place when obstruction is rapidly developed.

Sometimes the mucosa above the constriction exhibits evidences of ulceration. This has been usually attributed to mechanical injury by retained fæces, etc., but it is more probably due to changes in the innervation of the injured intestinal wall, rendering it more susceptible to the action of chemical and microbic agents within the cavity of the bowel. The serous investment of the intestine frequently exhibits extravasations of blood that are due to the same causes. Peritonitis, either from perforation of the intestinal wall or generalized over the entire peritoneum, is not an uncommon incident.

The internal organs of the body frequently appear to be very dry in consequence of the loss of water through excessive vomiting. Sometimes catarrhal pneumonia is excited by the passage of vomited matters into the trachea and bronchi.

It is not usual to find more than one point of occlusion in the same intestine. Multiple constrictions are very rare. Knotting together of separate intestinal coils usually occurs at the sigmoid flexure, which becomes involved with the coils of the ileum. Twisting of the intestine upon its own axis usually occurs in the ascending colon. Twisting about the mesenteric axis is generally observed at the sigmoid flexure, where the mesenteric folds permit unusual freedom of motion. Accord-

ing to Leichtenstern, 59 per cent. of the cases of intestinal torsion are found in the immediate vicinity of the sigmoid flexure.

Symptoms.—The symptoms of stenosis of the intestinal canal are chiefly connected with difficulty of evacuating the bowels, while the symptoms of complete occlusion are marked by total arrest of defecation. In many cases there is a persistent torpor of the bowels, which may be mistaken for simple constipation so long as it can be relieved by the use of coarse food, fruits, and vegetables. Sometimes, however, the ingestion of such articles, containing seeds, husks, and undigestible fibres, may suddenly transform a case of mere stenosis into complete stoppage of the bowel.

In many instances, especially when the rectum is narrowed by syphilitic or cancerous disease of its wall, there is set up a severe catarrhal inflammation of the mucosa above the point of constriction, and chronic diarrhœa exists as a consequence. When no such looseness of the bowels is excited, the fæces are often modified in their form, so as to be voided in little pellets like sheep's dung, or they are flattened out like pieces of tape. Sometimes, when the contracting induration is confined to one side of the bowel, the fecal cylinder is merely grooved on one side where it is crowded against the obstruction. In estimating the importance of these appearances it must not be forgotten that neurasthenic victims of chronic constipation sometimes void ribbon-like fæces as a result of nothing worse than intestinal torpor—a condition in which spasmodic stricture may easily occur. When the colon or the rectum is the seat of constriction, evacuation of the bowels is commonly attended with great pain. Hemorrhoids are of frequent occurrence by reason of pressure upon the large rectal veins.

Inspection of the abdominal surface during the course of the disease often discovers great distention of the belly through retention of fæces and gas. If the patient be somewhat destitute of subcutaneous fat, the coils of the distended bowel may be noted immediately beneath the wall of the abdomen. Often the peristaltic movements of these coils can be readily perceived as the muscular coats contract in the effort to urge the intestinal contents through the constricted portion of the canal. Audible sounds, caused by the displacement of the liquid and gaseous constituents of the fæces, can often be heard under such circumstances, and the movement of the intestinal contents can be plainly distinguished when the palm of the hand is laid upon the abdominal surface. By careful observation in this way it is sometimes possible to locate very exactly the site of the constriction. Exploration through the rectum and vagina should never be omitted. When the finger cannot reach high enough, it may be aided by the use of a rectal sound. Introduction of the entire hand and forearm into the rectum and lower bowel has been sometimes accomplished as a method of investigation, but, obviously, this is an operation that can be performed only under profound anæsthesia, and it is permissible only when the surgeon is gifted with a small and adroitly guided hand, since the risk of rupture is much greater than in experimentation upon the dead subject. Very little information can be derived from the use of the rectal speculum or from rectal injections; but in female patients the exploration of the pelvis through the vagina and rectum is often of great service.

When complete occlusion of the bowel has occurred the condition has received from the older authors a number of expressive names, such as ileus, miserere, passio iliaca, and volvulus. Three principal symptoms indicate its existence: arrest of fecal evacuation, retention of flatus, and vomiting of the contents of the alimentary canal. The cause of the arrest of downward movement in the intestine is sufficiently obvious, and the occurrence of vomiting is readily explained by reference to the reversal of peristaltic action that sooner or later follows stoppage of the bowel. Occasionally, however, this symptom does not appear until very late in the course of the disease. The matters thus ejected consist at first of the ordinary contents of the stomach mixed with fungous parasites and masses of normal fecal substance. But after a little these are replaced by a thin, watery, offensive liquid that contains fecal débris in a highly diluted state. Toward the end of life vomiting sometimes ceases and is replaced by an obstinate hiccough. All these symptoms of reversed peristaltic action with fecal discharge have been referred to colonic obstruction alone; but this is an error, for I have myself witnessed the characteristic vomiting of fæces when the seat of obstruction was above the ileo-cæcal valve, in the lower portion of the small intestine.

The general abdominal symptoms are similar to those that have been already described as a consequence of intestinal stenosis, but they are usually carried to a greater extreme. The distention of the belly is greater and the intestinal coils are more conspicuous. Dulness on percussion can be sometimes discovered over the seat of obstruction, and a tumor can be felt at that point in a certain number of the cases. Localized pain accompanies palpation of the abdominal wall under such circumstances, and the peristaltic movements of the bowel are often attended with colicky pangs. The urine is greatly diminished in quantity by reason of the evacuation of fluid that is connected with the act of vomiting. It usually contains indican, because the indol that is formed in the small intestine is no longer discharged with the fæces, but is reabsorbed into the blood and appears as indican in the urine. When the function of the pancreas is arrested by coincident disease of that organ, the urine contains no indican, because under such conditions indol is no longer formed in the small intestine.

The patient rapidly sinks into a state of collapse almost like that of cholera. He tosses uneasily from side to side and can find no relief. The temperature is frequently subnormal, but it may exhibit irregular ascensions upon the scale. The pulse is usually weak and rapid. Consciousness is ordinarily retained until the very last moment of life. In certain cases a species of auto-intoxication is evident, with symptoms that resemble the phenomena of poisoning with atropine.

A fatal result is sometimes reached in a very short time, as if produced by a violent shock to the nervous system. Occasionally a miserable existence is prolonged for many days, or even for a number of weeks before exhaustion ends the torment. Sometimes death occurs suddenly by reason of suffocation through the entrance of vomited matters into the trachea. In other cases dissolution is hastened by the upward pressure of incarcerated gases against the diaphragm and the thoracic organs. In certain instances death follows the occurrence of rupture of the over-distended intestine, either directly as a consequence

of the shock, or indirectly as a result of subsequent peritonitis. In many cases peritonitis occurs without perforation of the bowel, and its incidence is often insidious, without pain even on pressure over the seat of inflammation. Occasionally a loop of intestine above the obstruction becomes adherent to the parietal peritoneum, and an artificial anus is formed by ulceration through the intestinal coats and the abdominal wall at the point of adhesion. In like manner, an occasional cure is effected by a similar process of union and ulceration between a loop above the occluded portion and another below it. Again, similar fistulous passages have formed between the intestine and the uterus, bladder, or vagina. Encapsulated abscesses may form within the abdominal cavity; pyæmic infection may occur; metastatic abscesses may occupy the liver; and the lungs may be invaded by infectious emboli. Recovery is not a very frequent result, though it does sometimes occur spontaneously or as a consequence of treatment. Sometimes the obstructive mass appears thrown off in the stools as a tumor, a slough, or some foreign body that had been lodged in the bowel. But usually recovery is ushered in by the return of flatus and fæces to the evacuations, after which the patient gradually enters upon convalescence.

Diagnosis.—The recognition of the fact of intestinal obstruction is usually unattended with difficulty, but the determination of the exact situation and cause of the trouble is often one of the most obscure problems in medicine.

The place of obstruction must be inferred from careful examination of the abdomen. The presence of indican in the urine is a valuable sign, since it indicates that a large portion at least of the small intestine is free for the performance of pancreatic digestion. It must not be forgotten, however, that the existence of peritonitis alone may increase the quantity of indican. The same thing is also remarked when cancerous growths are developed in the rectum, even though peritonitis be absent. As a general fact it may be assumed that when obstruction exists in the small intestine all the symptoms are exaggerated beyond what obtains when the large intestine is the seat of occlusion. Still, it must be admitted that this rule has its exceptions.

The particular cause of the obstruction can be ascertained with tolerable certainty when the point of occlusion can be reached through the rectum or vagina, or when the existence of a strangulated hernia can be demonstrated. Sometimes the diagnosis is greatly simplified by the sudden discharge through the anus of a tumor or invaginated portion of the intestine that has sloughed off, or a gall stone or coprolith of preternatural magnitude, or of some foreign body that had been lodged in the bowels. When old people experience obstruction of the intestines, it is frequently due to the growth of a latent cancer involving some portion of the gut. In fact, the existence of latent abdominal cancer should always be suspected in the obscure and wasting decline of advanced age. Incarceration of an intestinal loop should also be suspected if the patient has previously suffered with adhesive peritonitis. In every case, moreover, careful search for hernias of every sort should be made. Especially true is this of females, in whom an unobserved femoral hernia may lead to strangulation and gangrene of the intestine, with fatal consequences to the patient.

Still, in spite of every effort there are cases that elude explanation until a post-mortem examination reveals the existence of a local inflammation or a simple paralysis of some portion of the intestinal tract. I have seen an infant die of obstruction above the sigmoid flexure within a week after birth, having never voided anything but a few drops of meconium, and on examination no cause of occlusion could be discovered except an inflammation involving the entire circumference of the bowel for a space of about two inches in the descending colon. Similar appearances of intestinal occlusion are sometimes encountered as a result of peritonitis or appendicitis or abdominal tumors, especially when they involve the mesentery. Arsenical poisoning and Asiatic cholera occasionally produce the phenomena of intestinal occlusion, with fecal vomiting, etc., but they may be differentiated by chemical and microscopical examination of the excreta.

Prognosis.—The prognosis depends upon the degree of occlusion. Obviously, an intestinal stricture that is still pervious is less dangerous than one that is completely closed. In cancerous cases the outlook is exceedingly unfavorable, even though the intestine should remain permeable. In non-malignant cases much depends upon the accessibility of the constriction and upon the energy and wisdom of the treatment. Under any circumstances the mortality is very great. According to Goldammer, medical treatment gives 30 per cent. of recoveries. The surgeons claim all cases of occlusion as fit subjects for laparotomy, but, according to Schramm, the mortality in 199 cases submitted to surgical treatment was not less than 61 per cent. Curtis, reporting 328 cases operated on with antiseptic precautions, gives a mortality of 68.9 per cent., which is about the same as the result of purely medical treatment. Among the later series of cases are 122 laparotomies, reported by Schramm, in which, by strict antiseptic methods, the mortality was reduced to 53 per cent.

Treatment.—When dealing with cases of simple narrowing of the intestinal tube, the diet should consist of liquids that leave a minimum of fecal residue. If solid food is taken, it must be very thoroughly chewed. The bowels must be kept freely open with laxatives and the various mineral waters, so that no hardened fæces can collect above the stricture. When located in the rectum the constriction may be reached through the anus, and may be sometimes relieved by dilatation or by more radical surgical measures.

In all cases of complete occlusion of the bowels, especially if of sudden incidence, the first thought should be directed to the possibility of hernia, and the entire abdomen should be explored with reference to that accident. It is true, moreover, that intestinal occlusion may occur as an independent affection in patients who suffer with hernia—a fact that does not diminish the difficulties in the way of diagnosis.

When occlusion has been effected as a consequence of the presence of coprolithic masses in the colon, it is necessary to thoroughly irrigate the bowels with a powerful stream of hot water from a large fountain syringe. This operation should be repeated as often as the strength of the patient will permit. After an evacuation has been thus procured the irrigation should be repeated at least twice daily, and purgatives should be administered. For this purpose the compound infusion of

senna with magnesium or sodium sulphate should be given daily. If thoroughly sweetened with licorice, prunes, and raisins, this is not a particularly disagreeable draught. Castor oil, reinforced with a drop or two of croton oil, is a very efficient purgative; and in certain cases, when the colon is fully charged with hardened fæces, it is well to attack the obstruction with the combined oils through the mouth and stomach, and with well-warmed injections of castor oil from below. Sometimes, however, it is necessary to precede the injection by a process of scooping the fæces from the rectum with a spoon, or with the fingers and whole hand in the bowel, before the tube of an irrigator can be introduced.

When the obstruction cannot be reached through the rectum or vagina, especially if torsion or incarceration of the bowels be suspected, the operation of laparotomy should be performed without delay. This should be done at the earliest possible moment, lest the occurrence of rupture of the intestinal wall or the incidence of peritonitis add to the dangers of the case.

Many surgeons have preferred the operation for an artificial anus to laparotomy. It is true that after thus opening the bowel above the point of occlusion the gravity of the symptoms sometimes subsides, and the fæces may even resume their normal course. But in other cases, in spite of the temporary relief afforded by an artificial opening, gangrene or diffusive peritonitis may still originate and extend from the primary seat of difficulty. According to Curtis, in 62 cases of enterostomy the mortality was only 51.6 per cent., and among the cases of recovery in 59.4 per cent. the fæces resumed their normal course through the bowels.

In difficult cases that cannot be treated by surgical operation it is necessary to relieve pain and to quiet the peristaltic movement of the intestines by the administration of opiates by the mouth or by hypodermic injection until the pupils are contracted and the patient can lie in quiet. This course is preferable to the use of drastic purgatives, which sometimes appear to aggravate the existing obstruction by the swelling of the mucosa which they excite. In many instances great benefit has accrued from repeated irrigations of the stomach with the gastric siphon. The operation should be performed three or four times every day. The relief in cases of fecal vomiting and accumulation of gas in the stomach and distended bowels is inestimable, and is sometimes followed by a cure in cases of invagination or incarceration of the intestine. Similar results have sometimes followed the injection of air into the rectum or the liberation of carbonic acid gas in the lower colon by the introduction of a solution of twenty grains of sodium bicarbonate in water, immediately followed by an equal quantity of dissolved tartaric acid.

Puncture of the distended coils of intestine with a fine trocar introduced through the abdominal wall has been successfully performed, and a cure has sometimes followed the operation. The same thing can be said of faradization of the intestine by the introduction of one electrode into the rectum, while the other is applied to the abdominal surface in the region of the cæcum and colon. Massage of the abdomen is to be thought of only when occlusion is due to coprostasis or to the presence of foreign bodies in the bowels without the existence of peritonitis.

INTESTINAL MISPLACEMENT; ENTEROPTOSIS.

The term "enteroptosis" is made to include misplacement and descent of any or all of the abdominal viscera. When the intestinal tube is at fault it is usually the transverse colon that falls out of place (coloptosis). This happens usually with feeble, nervous women, frequently after childbirth, sometimes as a consequence of congenital length and laxity of the mesentery. It may also occur as a result of obstinate constipation or of violent muscular exertion of any kind. It is in anæmic, neurasthenic persons that it is frequently witnessed, and it is in its turn often an efficient factor in the aggravation of the conditions by which it is caused. This results largely from the uneasiness and abdominal distress to which the patient is a permanent victim. Chronic constipation, bad digestion, and considerable emaciation are commonly observed.

The existence of coloptosis can be readily demonstrated by inflating the colon with air. The distended bowel can be then easily discerned through the abdominal wall, unless that be uncommonly laden with fat.

Intestinal displacement occasions no special danger to life, but it is certainly a source of great inconvenience, to say the least, and it may cause great emaciation and depression of spirits.

The TREATMENT should consist in provision of a well-fitting abdominal band or supporter, by which the pendulous abdomen can be lifted up and retained in its normal position. Constipation must be prevented. Daily cold sponge baths and other methods for the improvement of the general health must be persistently employed.

HEMORRHOIDS.

SYNONYMS.—Piles; Phlebectasia hæmorrhoidalis; Hæmorrhois; Hæmorrhoiden; Goldene Ader.

ETIOLOGY.—Hemorrhoids consist in a more or less varicose enlargement of the hemorrhoidal veins. This condition may be induced as a local expression of a general morbid state of the circulatory apparatus, leading to dilatation and varicosity of the veins in other parts of the body and limbs, or it may result from accidental causes, such as obstinate constipation and violent straining at stool. In certain cases hemorrhoids are produced by obstruction to the portal circulation through the liver, and they are often the result of causes which also operate to produce at the same time a chronic catarrhal inflammation of the rectal mucosa. In like manner they are frequently associated with that vast array of symptoms that is presented by the victims of the gouty diathesis. In other cases, on the contrary, they seem to be the result of purely local causes, such as chronic proctitis or strictures of the rectum occasioned by cancerous or syphilitic disease involving that portion of the bowel.

Just as pressure from within the rectum can produce hemorrhoids,

so may they be occasioned by pressure from pelvic growths or tumors outside of the intestinal canal. Witness the common results of pregnancy. Enlargements and tumors of the uterus, ovaries, and prostate sometimes operate in the same way by hindering the rectal circulation. A similar result is not infrequently caused by obstructive diseases of the portal vein or of the liver, or by pressure upon the large abdominal vessels during the growth of intra-abdominal tumors—a result that is especially favored by the absence of valves in the rectal and portal veins.

Ascending still farther, we may find the hindrance to the return of blood from the lower bowels located in the form of diseases of the heart and lungs which interfere with the proper movement of the blood. Thence stagnation in all the veins, with consequent hemorrhoidal development in the rectum. Such conditions are frequently induced by a life of indolent luxury, in which excesses at the table unite with lack of exercise to induce obesity and all those errors and diseases of nutrition that are associated with the gouty condition. It is probably for this reason that in many instances heredity seems to play a part in the etiology of the disease: hemorrhoids are not hereditary, but their causes in the way of wealth, luxury, and indolence may be sometimes transmitted from generation to generation.

For the same reasons that induce gout more frequently among men than among women, hemorrhoids are most often experienced during the fourth and fifth decades of life, the period when the passions and appetites are most freely indulged. To find young children suffering with piles is a rare event, and only to be looked for under wholly abnormal conditions.

Pathological Anatomy.—For obvious reasons, the position and growth of piles can be studied more conveniently upon the living body than upon the dead subject. We find them formed above and below the sphincter ani muscle—hence their classification as external and internal hemorrhoids. Sometimes they are wholly external and below the sphincter; sometimes they are above the muscular ring and internal; sometimes both varieties are present at the same time. Usually they occupy the immediate neighborhood of the sphincter, but they are sometimes found as high as the sigmoid flexure, constituting a generally varicose condition of the rectal veins. The form of the different hemorrhoidal clusters is consequently subject to great variation. External piles may be so numerous and so large as to appear like a bluish black collar composed of irregular links or disks surrounding the anus, or they may exist as occasional, circumscribed, wartlike tumors placed at considerable distances from each other around the anal opening. In the case of old hemorrhoids the individual tumors are usually covered with a dense cuticle, but recent growths, especially upon their anal surface, possess a very thin and transparent investment, through which the dilated veins in the centre of the mass can be discerned.

Above the sphincter ani muscle internal piles present a great variety in form and size. They are simply covered by the rectal mucosa, and are usually broad and flat, with an equally sessile base; but sometimes they are raised upon a comparatively slender stalk, almost like that of a rectal polypus. Not unfrequently such hemorrhoidal growths pro-

lapse through the anus and become strangulated by spasmodic contraction of the sphincter ani muscle.

Chronic catarrhal inflammation of the rectal mucosa is a very common complication of hemorrhoids. This may proceed to the extent of ulceration and suppuration, occasioning a constant annoying muco-purulent discharge from the rectum. The deep connective tissue of the bowel may also be involved in this process, even to the occurrence of abscess in the rectal wall. Such abscesses may open internally or externally, or in both directions, constituting incomplete or, in the last case, complete rectal fistulas.

The veins that are implicated in the hemorrhoidal structure may undergo various changes. They may dwindle and return to normal conditions, as after parturition, or they may become obliterated by the formation and organization of thrombi within their lumen. These thrombi occasionally undergo calcareous degeneration, with the consequent production of phleboliths in the once permeable veins. Sometimes the close pressure of one dilated vein upon another leads to the gradual atrophy and disappearance of their intervening walls, so that their cavities coalesce, with the production of a sort of angio-cavernous tumor.

Symptoms.—Every one knows how irregular is the connection between symptoms of rectal distress and actual lesion of the hemorrhoidal vessels. In many instances there is great complaint, with scarcely any local change to account for it, while in other cases considerable varicosity of the rectal veins may exist without corresponding uneasiness on the part of the subject.

But, as a general rule, the presence of hemorrhoids gives rise to great discomfort. There may be a constant sensation as if the rectum were occupied by a foreign body, or there may be complaint of burning and smarting about the anus, with spasmodic muscular jerking and throbbing in the rectum. Sometimes the act of micturition is attended with extraordinary pain. All such symptoms are induced or greatly aggravated by long-continued sitting, horseback riding, or excessive indulgence in venery and in the pleasures of the table. When the anal orifice is closely encircled by a ring of inflamed piles—especially when the adjacent mucosa at their base is fissured or ulcerated—the act of defecation is often attended with such agony that it is postponed as long as possible, only thereby adding to the suffering of the patient when the bowels are finally evacuated. In certain cases the patient may actually faint or be convulsed by reason of the severity of the pain. Sometimes, also, the whole of the alimentary canal participates in the disturbance that is thus excited, and the entire nervous system is upset by the commotion, so that there will be tenesmus, nausea, vomiting, palpitation of the heart, difficulty of breathing, determination of blood to the head, noises in the ears, disturbances of vision, dizziness, faintness, and loss of consciousness. Such cases, however, are fortunately of rare occurrence.

Sometimes, when the hemorrhoids are internal, the most notable symptoms are connected with a constant leaking through the anus of a slimy, muco-purulent discharge from the inflamed mucosa. But the most characteristic discharge consists of mucus and blood that are fur-

nished by a continuous capillary oozing from the rectal surface. Occasionally there is actual rupture of a dilated vein, so that the patient may be drenched with his own blood. More frequently, however, the veins do not give way, even though greatly distended or obstructed by clotted blood in the centre of the hemorrhoidal tumor.

These sanguineous discharges, unless of extraordinary amount, usually confer great relief upon the patient. A moderate hemorrhage soon makes an end of the cerebral or thoracic symptoms by which it was preceded. Since it has its origin very near the anal orifice, the blood that is evacuated has a bright and fresh color, is nearly pure, and is not mixed with fecal matter. It may be smeared over the exterior of the fecal cylinder, but is not incorporated with its substance. Very rarely is the quantity sufficient to endanger life by its loss, but in many cases of chronic hemorrhoidal bleeding the patient may become greatly reduced, and may exhibit all the symptoms of profound anæmia.

The prolapse and strangulation of pendulous internal hemorrhoids lead to most painful and sometimes dangerous situations. The patient lies groaning on his side, with his thighs drawn up against the belly, and exhibits every symptom of the most intense suffering. Unless placed under the influence of ether the attempt to replace the mass within the sphincter ani muscle only adds torture to the pain that is already experienced. If reduction of the piles cannot be effected they soon become gangrenous, and the patient may succumb to the consequences of septic infection.

Hemorrhoids are of limited duration when dependent upon transient causes like constipation, pregnancy, etc., but in the majority of cases they have their origin in chronic disorders of the circulatory apparatus or of the respiratory and digestive organs, or they are an expression of nutritional vices that are based upon the habits that produce obesity and other diseases of the gouty type. Consequently, like the conditions with which they are inextricably associated, they usually persist with greater or less degrees of severity throughout the remainder of life.

Diagnosis.—The recognition of hemorrhoids is not difficult, since external piles are easily inspected and internal piles can be readily reached with the finger or the speculum. It is only needful to keep in mind the distinction between enlarged hemorrhoidal veins and such diseases as cancer of the rectum, broad condylomata, and an unusual fulness of the folds in the pouches of the rectum. A ready means of distinction consists in the fact that such tissues do not bleed on puncture with a fine trocar, whereas hemorrhoidal tissues bleed freely when thus treated.

Prognosis.—So far as the life of the patient is considered, the prognosis is good. Only in cases of strangulated and gangrenous hemorrhoids is there any considerable danger. But the prospect of permanent cure without relapse except by surgical operation is far from encouraging.

Treatment.—Prophylactic measures are of the greatest importance in the management of hemorrhoids. Constipation must be obviated by appropriate treatment. The diet must be properly regulated so as to avoid the forms of malnutrition that follow habitual excess in eating and drinking. The idle and luxurious members of self-indulgent fam-

ilies must be made to use their muscles in healthy exercise and to overcome the propensity to excessive venery that accompanies an indolent life. Not only alcohol, but strong tea and coffee, must be abandoned—in fact, one must look with suspicion upon the majority of the comforts of civilized life.

When constipation and a moderate hemorrhoidal tendency are present, the bowels should be kept gently open by the daily use of small doses of compound licorice powder or of Garrod's tablets containing in each a grain of bitartrate of potassium with five grains of pure precipitated sulphur. As usually furnished, these tablets are too hard and disagreeable to the taste, but with a little care they can be made as agreeable as any sweetmeat. After every evacuation of the bowels the parts adjacent to the anus should be thoroughly washed and wiped with tissue-paper. The best and most convenient method consists in irrigating the anus with a barber's spray attached to the cold-water faucet of a foot-bath tub, over the side of which the patient can place his hips in the sitting posture.

Great benefit may be often obtained from a summer at Saratoga Springs or at other similar alkaline sulphate sources. Laxative waters that are strongly impregnated with sulphur are useful in arthritic cases accompanied with piles. For chronic patients who have become anæmic from frequent losses of blood the iron waters are to be recommended. Plethoric patients derive benefit from the so-called milk and grape cures. Almost any change of diet, climate, and occupation is attended with at least temporary benefit; hence the advantage of an outing among the mountains or by the seaside.

When external piles are troublesome it is frequently necessary to smear them with various oleaginous substances. If painful, they may be anointed with unguentum gallæ cum opio. If pain is felt in the deeper recesses of the rectum, it may be necessary to resort to the use of anodyne suppositories containing morphine and atropine. Inflammatory conditions call for local applications of lead water and laudanum or of the liquor aluminii acetici (one part to one hundred of water). Blennorrhagic conditions of the rectum call for daily injections with cold water, followed by injections of astringents like tannic acid (ten or fifteen grains in a fountain-syringeful of water), or a grain or two of nitrate of silver in a similar quantity.

Excessive hemorrhoidal bleeding should be treated, just like a case of epistaxis, by local applications, ice-plugs, rectal tampons, and, above all, by a full dose of calomel and bicarbonate of sodium. Moderate bleeding will ordinarily yield to a mercurial cathartic associated with the internal administration of the astringent preparations of hydrastis canadensis. In mild cases the internal use of the distilled extract of witch hazel in teaspoonful doses is often sufficient. Hot-water injections are sometimes more grateful to the patient than cold, and are often quite as effectual.

Prolapse and strangulation of internal hemorrhoids call for truly surgical methods of treatment. The patient should be etherized, after which it is comparatively easy to dilate the anal orifice, incise the hemorrhoidal tumors, evacuate their contents, and replace the remaining masses above the sphincter muscle, confining them in place by an anal

pad supported by a well-adjusted T bandage. But if, as I have seen, the agonized patient refuses such treatment, the slower methods of calomel catharsis, antiseptic poulticing, and anodyne applications must be employed—sometimes with gratifying results. In many instances the application of several leeches to the anus will bring great relief through the unloading of turgid veins that is thus effected. But, as a general fact, when hemorrhoids continue to relapse and to torment the patient in spite of the above indicated measures, it becomes necessary to invoke the intervention of the surgeon.

APPENDICITIS.

By W. F. McNUTT, M. D., M. R. C. S. Edin., etc.

Synonyms.—Ecphyaditis; Typhilitis; Cæcitis; Perityphlitis; Paratyphlitis; Phlegmon of iliac fossa; Iliac abscess; Tuphlo-enteritis; Typhlo-enteritis.

Definition.—Inflammation of the appendix vermiformis.

Pathologically, typhlitis or cæcitis and perityphlitis are not synonyms of appendicitis; inasmuch, however, as cæcitis and appendicitis cannot be in most cases, at the present time, clinically differentiated, we will consider under the head of Appendicitis the whole group of symptoms which go to make up both of these diseases. When we are able to interpret their *diacritica signa* we will limit the use of the word appendicitis to inflammation of the appendix, and use the word cæcitis, or typhlitis, where the inflammation is confined to the cæcum. When we are able to diagnose inflammation of both cæcum and the appendix we can coin the term typhlo-appendicitis; and when we can diagnose appendicular colic we may coin the terms appendalgia and ecphyadalgia. In the mean time there is no objection, but much propriety, in substituting the term appendicitis for typhlitis and perityphlitis, for the reason that the group of clinical phenomena which constitutes these diseases is much more frequently produced by appendicitis than by typhlitis.

We do not, however, believe, as do Talamon and some other writers, that the word "typhilitis" is doomed to disappear and give place to the name "appendicitis." On the contrary, we hope that in the near future we will be able to as readily and clearly differentiate between cæcitis and appendicitis as we can now diagnose bronchitis from pneumonia. Not a few writers are so carried away with the new term or new disease appendicitis that they deny even the possibility of such a disease as typhlitis. Talamon's translator grows so enthusiastic that he "relegates typhlitis and perityphlitis to the land of myths and fables." Such writers must surely forget that no portion of the alimentary canal, from the upper end of the œsophagus to the anus, is exempt from inflammation; that fecal impaction is one of the frequent causes of inflammation and ulceration; and that the sigmoid, the rectum, and the cæcum are the three places in the alimentary canal most liable to impaction. We are aware that Munchmeyer, Behier, and some others deny the possibility of stercoral impaction producing inflammation of the mucosa. Surely, stercoral impaction of any part of the intestine or appendix will distend the walls, compress the bloodvessels, disturb nutrition, and thus denude the mucous membrane of its epithelium. Micro-organisms

will invade this pathological soil, will multiply as the sands of the sea, will infiltrate, devastate, and penetrate the walls. In many cases the group of characteristic symptoms that we now call appendicitis is produced in this way. It is not necessary to theorize about the possibility of disease of the cæcum. Surgical operations and post-mortem examinations have demonstrated inflammation and ulceration of the cæcal mucosa and perforation and gangrene of its walls. Since typhlitis, perityphlitis, and perforative typhlitis are well-established diseases, we are at a loss to understand how they are "doomed to disappear" or how they are to be "relegated to the land of myths and fables." Unfortunately, diseases are as difficult to suppress as Banquo's ghost, and typhlitis, like the poor, will be always with us.

The word *typhlitis* seems to have been first used by Albers. The term *perityphlitis* is, I believe, thought to have been first used by Golbeck; Oppolzer was the first to use *paratyphlitis*. Appendicitis is not in the 1874 edition of Dunglison, and not even in the *National Medical Dictionary*, though it was published only three years ago; nor is the word to be found in the new third edition of Vierordt's *Medical Diagnosis*, published this year. Yet Mestivier reported a case of perforation of the appendix in 1759, Wegeler 1 in 1813, Melier 4 in 1827, and Copland cases in 1834.

Etiology.—A careful consideration of the causes of appendicitis is of the greatest importance. In a typical case of course a diagnosis is easily made. In many cases, however, it will be found necessary to weigh all the etiological factors in this protean abdominal disease as an aid in diagnosis; and to enable us to determine the pathological conditions which call for surgical interference the causes are best studied under the headings of (1) *predisposing* and (2) *exciting*.

(1) Predisposing Causes.—*Climate* seems to have no appreciable influence, and season only so far as cold and wet weather may predispose persons to inflammation of the abdominal organs.

Age by all writers is considered a very important predisposing factor; age, *per se*, is not, however, in any sense, a predisposing cause of appendicitis: it simply engenders habits and occupations which predispose the individual to appendicitis. Age, therefore, is of great clinical importance in a matter of differential diagnosis. The disease is not frequent at the two extremes of life. It has been advanced that the exemption of young children is largely owing to the peculiarities of the tube and mucous membrane about the cæcal orifice, that the tube is funnel-shaped, and that the opening is better guarded by the valve of Gerlach. On the other hand, in old age, it is claimed, the exemption depends upon the widening of the mouth of the tube by atrophy of the membrane, and should a foreign body find its way into this widened tube, it would be more easily expelled by the muscular contraction which its presence would excite; according to this, appendalgia would be more frequent in advanced life, which is not the case. This theory was constructed when it was supposed that nearly all cases of appendicitis were the result of lodgement of foreign bodies. Nursing children rarely suffer, while between the ages of two and ten we may count upon meeting with about 10 per cent. of all the cases of appendicitis; between the ages of ten and thirty, about 65 per cent.; between the

ages of thirty and fifty, about 20 per cent.; and only about 5 per cent. will occur after the age of fifty. It will thus be seen that quite 80 per cent. of all the cases of appendicitis are met with between the ages of ten and forty. This showing makes age an important etiological factor from a clinical standpoint. It does not seem to indicate, however, that the appendix is more easily inflamed between the ages of ten and forty than before and after these ages, but on account of habits and occupations before ten and after forty there is an absence of causes.

Nevertheless, these years in a measure correspond to the most active developmental period in the history of the appendix, according to Piersol.[1] He gives from the tenth to the twentieth year as the most active in the life-history of the appendix. In the declining years of life changes take place in the mucous membrane which lessen the canal, and Lieberkühn's follicles become atrophied. These changes, according to Piersol, frequently result in complete obliteration of the lumen. If, however, it was the condition of the appendix, and not the habits and occupation of the individual, that produce 80 per cent. of these cases between the ages of ten and forty, women should as surely have appendicitis as frequently as men. Then, again, in those cases of obliteration of the lumen which is so frequently found in old age may it not be the result of catarrhal appendicitis, and not as a process of involution, as considered by Piersol, Ribbert, Zuckerkandl, and many others?

Sex.—About 80 per cent. of the cases of appendicitis occur in males, only 20 per cent. in females. On account of this showing writers generally consider sex, like age, a very important predisposing etiological factor in appendicitis. Most writers on the subject are free to confess that they have no explanation to offer why the male suffers so much more frequently from appendicitis than the female. In textbooks on anatomy no difference of construction or structure between the male and female appendix is mentioned. Clado, however, claims that he has discovered a fold of peritoneum passing from the ovary to the appendix or its mesentery, and that this fold carries an artery. Should this anatomical difference be found to exist, the terminals of the artery of this fold no doubt anastomose with the terminals of the appendicular artery. Thus the appendix of the woman has a better blood supply, and consequently a greater vitality, than that of the man, and will not so readily suffer from nutritive disturbances, gangrene, perforating ulcerations, etc. That this ovarian appendicular ligament is not always present is certain; that it may be occasionally is probable. It is entirely unnecessary to construct imaginary anatomical differences to account for the greater percentage of appendicitis in men than in women. We need look no farther than habits and occupations for an intelligent and sufficient explanation of the circumstances. No one would think, for instance, of claiming that a woman's arteries are, on account of their anatomical structure, less liable to aneurysm than a man's, yet we know that men, owing to their habits and occupations, are as much more subject to aneurysm than women as they are more subject to appendicitis, the greater relative percentage in man being about the same for each disease. It is a good rule to remember that when the comparative frequency of disease in the corresponding organs differs in the sexes, the

[1] *Univ. Med. Mag.*, Sept., 1895.

cause of the difference is not always in the histology, anatomy, or physiology of the organ, but in the habits of living, dressing, occupations, etc. of the sexes.

Anatomy.—The circulation of the appendix and its anatomical relation to the digestive tract are fruitful predisposing causes of appendicitis. Impaction of any part of the intestinal tract is liable to cause atony or inflammation or ulceration or perforation at or near the seat of the impaction. In most cases of intestinal impaction, however, the fecal matter can be dislodged before perforation takes place, and if it has caused inflammation or ulceration, the parts often recover soon after the dislodgement has been once effected. When the cæcum is the seat of impaction and the fecal matter finds its way into the appendix or is forced in, it is not likely to be removed by the cathartic that empties the cæcum, as the appendix is off the line of travel, as it were, being a blind pouch or diverticulum from the cæcum, and well calculated from its anatomical relation to retain its scybalous contents. If a branch of the Sylvian artery becomes obstructed by embolism or thrombosis, the part of the brain supplied by that particular branch is likely to suffer a nutritive disturbance, and, should the same accident happen to an artery of the stomach, a round or perforating ulcer is likely to occur. In both instances the trouble arises because there is no free anastomosis of the extremities of these arteries with the terminals of other arteries. The appendix vermiformis depends for its blood supply upon a small terminal artery, a branch of the ileo-colic, whose terminals do not obtain blood from any other source by anastomosis, hence its great liability to perforation and gangrene. The appendix is usually about four inches in length, and is supplied by a mesentery or fold from the lower fold of the ileum for only about one half of its length.

The peritoneal fold that runs from the ileum to the mesentery of the appendix contains no arteries. Any great distention of the cæcum with fecal matter or gases is liable to disturb the nutrition of the appendix by drawing on its mesentery and thus lessening the blood supply.

Anæmia of the Appendix.—Anæmia is one of the marked predisposing causes of appendicitis. There are very many causes for anæmia of the appendix; for instance, strain on or torsion of the artery, thrombosis or embolism, contraction of the wall on a foreign body, and hyperplasia of new fibrous tissue of the appendix and its mesentery, the latter constituting stenosis or stricture of the appendix from cirrhosis. The introduction of scybala or other foreign bodies which provoke contraction of the walls of the appendix interrupts its venous circulation and lessens its vitality. That the nutrition of the appendix is disturbed as above described is evidenced by the fact that often when the wall of the appendix is found contracted on a foreign body there is an intense passive congestion; the perforation or gangrene is above the foreign body—that is, nearer the terminal point—and gangrene has been found with a greatly distended cæcum where no foreign body was present in the tube, but was the result evidently of torsion or strain on the appendicular artery and nerves. Scybala cause nutritive disturbances by obstructing the lumen of the tube in addition to disturbing the circulation. The occlusion of the tube pro-

duces an accumulation of the secretion of the mucous lining, which distends the walls, compresses the veins, establishes a passive congestion of the appendix, and makes an excellent culture tube for intestinal micro-organisms. What with the congestion and distention of the walls, the appendix suffers a neurotic as well as a circulatory disturbance, and inflammation, perforation, and gangrene result.

Habits and Occupation.—The few cases of appendicitis which appear in infancy are as liable to occur in the female as in the male child, and for the very simple reason that their habits and occupations are the same. When boys arrive at the fighting, kicking, wrestling, climbing, swimming, etc. age, they develop more cases of appendicitis than do girls of the same age. Many writers have sought for differences in the anatomical construction to account for appendicitis being so much more frequent in boys than in girls and in men than in women. We have not the slightest doubt that habits and occupation satisfactorily account for the occurrence. Wrestlers and gymnasts; house-carpenters who throw themselves across timbers and draw up heavy weights; clerks who stand upon ladders and take down heavy carpets and bolts of cloth; and many other occupations that call for great exertion, especially in strained positions,—in my experience often develop the disease. In short, any occupation or exertion that produces violent contraction of the abdominal muscles and compression of the intestinal contents may either force the gases of the colon into the appendix, thus expanding it and the valvular opening, and making it easy for the intestinal contents to enter, or probably not infrequently may force the fecal matter directly into the appendix, or may so strain or twist the meso-appendix that thrombosis of the artery may result.

My own experience has furnished many examples of appendicitis which resulted directly or indirectly from occupation. School-boys, for instance, furnish a goodly percentage of cases, which can generally be traced to running, leaping, wrestling, or some other direct violence. The habits of life which are conducive to functional and nutritive disturbances of the bowels, such as constipation, atony, catarrh, generation of gases, etc., predispose the individual to appendicitis.

Constipation as a cause of primary appendicitis is certainly much over-estimated by writers on the subject. The number of cases of constipation are out of all proportion to the number of cases of appendicitis; besides, constipation is more common with women than with men. The reason why constipation is not a more frequent predisposing factor in appendicitis is simply because in most cases of constipation the accumulation of fecal matter is in the sigmoid or the rectum, or both. Constipation only becomes a predisposing factor in appendicitis when the accumulation is in the cæcum. When the cæcum becomes over-distended with fæcal matter the opening into the appendix necessarily becomes enlarged, and any violent contraction of the abdominal walls induced by occupation, or perhaps straining at stool, or falls or blows, may readily force fecal matter into the appendix; or the stercoral impaction may produce a cæcitis which invades the appendix. Or the overloaded and weighted cæcum may so drag upon the mesoappendix that the artery becomes compressed and nutritive disturbance follows. Ramm,[1] in considering

[1] Ewald's *Year-book*, 1897, p. 170.

the nature of appendicitis, concludes that it is "due to the incarceration brought about by sudden dilatation of the cæcum. This causes retention of the contents of the appendix, hyperæmia, epithelial desquamation, and consequent infection." No such accident can possibly happen from constipation when the accumulation of fecal matter is in any other part of the alimentary canal, unless in rare cases the colon and cæcum are so distended by gases that they are liable to be displaced and drag upon the mesoappendix, or it may be possible for the gas to dilate the appendix, thus rendering it a ready receptacle for fecal matter or foreign bodies.

Diarrhœa.—Some writers consider this condition as predisposing to appendicitis. When inflammation of the cæcum is the cause of the diarrhœa the inflammation may readily extend to the appendix. When the diarrhœa is the result of *ileo-colitis* the appendix may very well become involved. Inflammation of any other part of the alimentary canal will not necessarily involve the appendix.

Diet.—Over-eating and drinking are well-established predisposing causes of appendicitis. Indigestible and too highly seasoned foods, by provoking catarrhal conditions, by distending the bowels with fecal matter and gases, are also etiological factors. Catarrh of the cæcum or about the ileo-cæcal opening may either invade the appendix directly or may act as a predisposing cause by giving rise to scybala, it being a well-recognized fact that scybala are met with in persons who are suffering with intestinal catarrh. Catarrh of the bowels disturbs two very important functions—viz. the secretions of the mucous membranes and peristalsis. With suspension of the peristalsis that portion of the bowel soon becomes distended with dried fecal matter or scybala, and when the condition occurs in the cæcum or lower portion of the ascending colon, it becomes a fruitful source of appendicitis. In the writer's experience appendicitis in children is very frequently preceded by catarrhal discharges from the bowels, more especially when the seat of the catarrh is an ileo-colitis. Since it is well established that most of the cases of peritonitis have their origin in appendicitis, and so many cases of appendicitis are caused by the lodgement of seeds in the appendix, much more care should be exercised in eating fruits. Many people are exceedingly careless about swallowing fruit seeds. In fact, patients often state that they have been told by their physician to swallow the seeds and skins of grapes or raisins for constipation. The practice is very dangerous. Cases of appendicitis have had their origin in the lodgement of a single grape seed. To swallow cherry stones, orange seeds, lemon pits, etc. is equally dangerous. A case of appendicitis occurred under my own observation which commenced within twelve hours after partaking pretty freely of grapes, the patient having swallowed seeds and skins. The habit of swallowing whole mustard seed for constipation is a bad practice. Physicians are often responsible for this dangerous prescription.

Infectious Diseases.—Any one of the infectious diseases may be the predisposing cause of appendicitis, but typhoid fever, diphtheria, abdominal grippe, tuberculosis, and syphilis are more likely to produce the trouble than the eruptive diseases. In all these ulcerated processes —viz. typhoid, diphtheria, tuberculosis, and syphilis—it is most prob-

able that the cæcum and the mucous membrane about the ileo-cæcal opening are the primary seat of the ulceration; however, as the mucous membrane of the appendix is generally provided with solitary glands, it may become the seat of specific ulceration independent of the cæcum. The specific ulcerations of the cæcum may so disturb the function of the appendix that it becomes invaded by the ordinary micro-organisms of the alimentary canal. It probably is the rule that the acute infectious diseases are predisposing causes, and very rarely the exciting causes.

Relapsing Appendicitis (*Remittent Appendicitis*).—Nothing is more certain than the influence of a previous attack in predisposing a person to appendicitis; we see this in our every-day practice. Once having had an attack, the patient is never absolutely safe from a recurring attack while the appendix remains, or unless the lumen becomes completely obliterated, which it occasionally does from repeated attacks (*appendicitis obliterans*). The relapses are usually produced by the presence of the foreign body still in the appendix, or it has left an ulcer or subacute inflammation of the mucous or submucous tissue, or there has been produced an interstitial inflammation of the appendicular walls. Again, the predisposing causes of the first attack may still be present—by the enlargement of the appendicular opening, for instance, which consequently leaves the organ exposed to the lodgement of foreign bodies and less able after each attack to expel them.

Stenostomia Appendiculæ Vermiformis.—Contraction of the appendicular opening is no doubt an occasional predisposing cause of appendicitis, and perhaps a very frequent cause of appendalgia. The stenosis is no doubt due to cæcitis or ulceration near the opening, the inflammation, or rather the cicatrization, narrowing the orifice. The accumulation of mucus in the appendix necessarily produces appendalgia, and the pain is only relieved when the spasmodic contraction of the walls of the appendix forces its contents through the narrow opening into the cæcum, which, of course, relieves the distention. Stenosis of the appendix, however, does not occur necessarily only at the cæcal opening. Stenosis may and often does occur in any part of the appendicular lumen; no better medium could be obtained or place invented for the culture of intestinal micro-organisms than the mucus which accumulates above the stricture.

(2) **Exciting Causes.**—The only cause for appendicitis, according to a layman's view of the disease, is a "foreign body in the blind pouch." A layman's opinion of a disease may not be worth much; in this instance, however, it is significant, as the common people must have obtained their notions of this disease from the medical profession, which goes to show that only a few years ago the profession scarcely suspected any other causes than that of a foreign body as the exciting cause of appendicitis; it was fruit seeds, cherry pits, or other small seeds, or foreign bodies that might have been swallowed, such as fish bones, pins, small coins, buttons, etc., or scybala or gall stones or enteroliths. Now that a reaction has set in against foreign bodies being the only exciting cause of appendicitis, there is danger of going to the other extreme and attributing too small a percentage of the cases to these causes. Some writers name not more than 3 or 4 per cent. as about the number to be

expected as the result of foreign bodies. According to Talamon,[1] "Out of a total of 760 cases of appendicitis obtained by collecting the statistics and observations of divers authorities (Fitz, Matterstock, Krafft, Fenwick, Maurin, Roux, etc.), in 450 the presence of such foreign bodies was noted in the appendix itself, sometimes in the pus of the periappendicular abscess—60 per cent." Fowler,[2] however, says: "The possibility of the production of the disease by foreign bodies is not denied; the statement is simply made that, as a clinical fact, in my experience it is of rare occurrence." Perhaps surgeons are too apt to conclude that there is no foreign body present if they do not find one in the appendix or in the pus cavity. Where the foreign body is a scybalum, it is always possible that it may have softened before the operation, either in the pus sac or within the appendix, by the accumulation of mucous secretion, or how easy for a small foreign body, such as a grape seed, to escape detection! When the scybalum or other round-shaped foreign body has obstructed the mouth of the appendix, the consequent accumulation of fluid in the cavity may have forced the obstruction into the cæcum, not, however before serious pathological changes may have been inflicted upon the walls of the appendix—lesions which may afterward terminate in ulceration, perforation, or gangrene; or the case may become a relapsing one on account of interstitial inflammation having been instituted. Then, too, there is a bare possibility that such cases may be nothing more than appendalgia.

Traumatism.—We learn by experience that a goodly number of cases of appendicitis are the direct result of blows, falls, lifting heavy weights, wrestling, etc.; 3 such cases have come under my own observation recently: one boy was kicked by a schoolfellow; another was punched with a stick over the cæcum; the third, a man, fell.

Stenosis.—There can be no doubt that stenosis of the mouth of the tube acts as an exciting cause, readily producing inflammation by dilating the tube, and thus interrupting the nutrition of the walls and preparing a proper soil for the destructive work of micro-organisms.

Cæcitis.—Of course inflammation of the cæcum very readily invades the appendix by extension, regardless of the etiology of the cæcitis. It must be remembered that the typhlitis which caused the appendicitis may have subsided, either because the cæcum has a better blood supply, or the impaction or foreign body may have been removed by cathartic medicine, while the inflammation in the less highly vitalized appendix may have resulted in perforation or gangrene. For instance, we not infrequently see a very mild catarrh of the stomach extend into the duodenum, and, though scarcely sufficient to disturb the patient, invade the ductus biliaris communis, causing tumefaction of the mucous membrane and obstruction of the duct, and a violent attack of jaundice ensues which may even endanger the life of the patient and necessitate a surgical operation. In the mean time, the duodenal catarrh may have subsided. We cannot see any reason which would lead us to infer that an appendicitis may not as readily result from a cæcitis as that a choledochitis may be caused by a duodenitis. In point of fact we have every reason to believe that the cæcum is much oftener the seat of inflammation and ulceration than the duodenum.

[1] Talamon, p. 30.

[2] Fowler, p. 68.

Microbic Appendicitis.—While it may not be possible to state in any given case of appendicitis the exact amount of responsibility which the intestinal micro-organisms played in its production, there is no longer any doubt that they are in many cases active etiological factors. Neither may it be possible to state in any particular case of appendicitis which of the many intestinal micro-organisms is the more active destructive agent. The bacterium coli communis is, however, the micro-organism that is not only most constantly found, but is present in the greatest numbers in the intestinal tract. While a sound intestinal mucous membrane seems to enjoy an immunity against its presence, it becomes an active pathogenic agent to the mucosa whose nutrition or physiological function is disturbed. Once the mucous membrane of the appendix is denuded of its epithelium, the bacillus coli communis assumes both pathogenic and pyogenic properties. Not only is this bacterium found in catarrhal inflammation of the cæcum and appendix, but it is also found in the peritoneal cavity in cases of appendicitis and typhlitis, and, too, when no perforation has taken place. It is very probable that in addition to catarrhal disturbance of the mucosa any atrophic or nutritive lesion of the appendix may subject it to invasion of bacteria. While bacteriological appendicitis is no doubt common, it must necessarily always be secondary to catarrh or vascular or nervous nutritive disturbances. Probably the more acute causes are secondary to the former, while the chronic causes are secondary to the latter.

Barbacci reaches the following conclusions: (1) "In perforative peritonitis in man cultures from the exudate yield only one organism in the vast majority of cases—the *bacillus coli communis*. In but a single case of the 14 was another micro-organism, the *micrococcus lanceolatus* (Fränkel), associated with the *bacillus coli communis*. (2) Inoculations into the peritoneal cavity of susceptible animals (white mice and guinea-pigs) with fresh exudate of peritonitis produce peritonitis, and in 8 cases out of the 13 the *micrococcus lanceolatus* was found. (3) The *micrococcus lanceolatus* is present in about 60 per cent. of all cases, but is overlooked because it is overgrown by the *bacillus coli communis*. (4) Experiments made on dogs by opening the abdomen, securing a loop of intestine, and causing a perforation by the application of caustic potash produced a peritonitis exactly simulating, both microscopically and bacteriologically, a perforative peritonitis in man. The animals died in from twenty to thirty hours, and examination after death showed a general fibrinous peritonitis. Enteritis was not found in any of the cases. Pure cultures of the *bacillus coli communis* were obtained from the exudate. (5) Marked differences exist as to the result when, upon the one hand, the examination is made directly from the exudate, or by the culture method on the other. Cultures show only *bacillus coli communis*, but by direct examination a number of different organisms may be found, the latter dying in the exudate in the early stages of the inflammation, the *bacillus coli communis* growing alone in the cultures. In dogs killed at intervals of five, five and a half, six, eight, and ten hours after perforation examination showed the *bacillus coli communis* mixed with other organisms up to eight hours; after this the former alone was found. The *micrococcus lanceolatus* was not found in the experimental peritonitis in dogs."

Rheumatism and Gout.—There are writers, especially in England, who attribute many cases of appendicitis and typhlitis to rheumatism and gout. The physicians of London probably have more experience with gout than those of any other country. When such a distinguished authority as Burney Yeo[1] is found adding the weight of his authority to the gouty and rheumatic origin of appendicitis and typhlitis, we are certainly obliged to admit that such cases do probably occur; and why not? Gout of any other part of the digestive tract is an established fact; gout of the stomach is quite a common expression.

A gouty enteralgia or diarrhœa is not an unusual occurrence. That a gouty or rheumatic typhlitis or appendicitis or ecphyadalgia should occasionally occur is what we might expect. There is no mucous membrane or serous tissue exempt from gouty or rheumatic inflammation. A boy, now aged fifteen, a patient of mine, had appendicitis (parietal) when eight years old, and again when ten; there was circumscribed peritonitis each time, but no pus and no operation. In the past five years he has had two attacks of tonsillitis, which readily yielded to salicylate of soda. His mother is a great cripple, and suffered from rheumatism since he was five years old. Would the appendicitis have yielded so readily to the salicylate? Its rheumatic origin did not occur to me at that time.

Pathological Anatomy.—The pathology of the appendix or of appendicitis is in no sense unique, and for the reason that its anatomy, histology, and physiology are quite the same as that of the cæcum, and subject to similar pathological laws. The appendix is simply a pouch or diverticulum of the caput coli, generally attached to its posterior internal side. The appendix or its four layers—viz. the serous, muscular, submucous, and mucous—is simply a jutting, as it were, of a circumscribed portion of the caput coli (not in an embryological sense, for the appendix embryologically is vestigial). "The histology of these four tunics is identical with that of the large intestines, with the two exceptions of the greater constancy of the solitary lymph nodes in the mucosa, and the complete outer sheath of longitudinal fibres in the muscularis. Fowler[2] says: "In the appendix Lieberkühn's glands and solitary follicles exist in such profusion that facilities for absorption are even greater than in the cæcum. Hence the contents of the appendix are always of firmer consistence than those of the cæcum." In applying the pathological laws of the colon to the appendix we will find that they are to a certain extent modified by the appendicular circulation, its anatomical relations to the intestinal tract, and more especially by the calibre of its canal. All narrow mucous canals must necessarily have a tendency to strictures and obliteration when the subject of catarrhal and ulcerative inflammations. The appendix has but one artery, and as about one half of its distal portion is usually free in the abdominal cavity without mesentery—that is, it is not attached to any other organ—its artery is necessarily terminal. Being thus deprived of anastomoses with the terminal branch of any other artery, a thrombosis or obstruction of its only artery must result in gangrene, perforation, etc. In the case of an appendicular ovarian ligament the artery which it carries

[1] *British Medical Journal*, June 16, 1894. [2] *Ibid.*, July 14, 1888, p. 43.

anastomoses with the appendicular artery, and a better blood supply is secured and gangrene and ulceration are not so likely to occur.

The pathology of acute appendicitis may be catarrhal, phlegmonous, ulcerative, necrotic, or gangrenous. Appendicitis may or may not terminate in abscess. Any one of these acute conditions may result in circumscribed or general peritonitis, with or without abscess and independent of perforation, the micro-organisms easily traversing the unbroken pathological walls. It is not, then, in its pathological laws that the appendix differs from any other portion of the alimentary tract, but in its greater tendency to pathological conditions, owing to the peculiarity of its circulation and anatomical relation to the intestinal canal, or, in other words, on account of its lower vitality or lesser power of resistance, for all vestigiary organs are lacking in vitality. The appendix is many times more subject to inflammation than the intestines, and the acute inflammatory processes are much more rapid and destructive. This is well exemplified in the appendicitis that results from scybalum, enterolith, or other foreign body impacted in the appendicular opening. The obstruction to the circulation of the appendix is at the point of impaction, while the ulceration or perforation is likely to be an inch or two nearer its terminal extremity, or the very apex is the seat of the gangrene. If impaction in any part of the alimentary canal could interfere with its circulation and nutrition in the same degree, its disturbed and disorganized walls would not as readily yield to the destructive power of the intestinal micro-organisms.

The pathology of the appendicitis that results from a torsion or stretching of the mesoappendix is about the same as that of obstruction from scybala. In the case of scybala the atrophic or nutritive lesion is primarily a passive congestion of the appendix, while in torsion of the mesoappendix the primary atrophic disturbance is anæmia. In either case the destructive agent is undoubtedly the micro-organisms.

The pathology of appendicitis which accompanies or follows typhoid, tubercular, or other infectious or specific diseases is similar to the pathology of enteritis from the same cause, modified, not from any peculiarity of the tissue, but on account of its blood-supply and its anatomical position. If a specific ulcer occurs in the mucous membrane of the appendix, it perforates more readily than specific ulcer of the intestinal wall. If the inflammation terminates in hyperplasia of fibrous tissue of the submucous membrane, a complete occlusion of the appendicular canal quickly ensues from cicatricial contraction on account of the narrow lumen of the appendix. The pathology of relapsing appendicitis is varied; repeated attacks occur with nothing more than involvement of the mucous membrane. When the attacks are catarrhal and the submucous tissue becomes involved, hyperplasia of fibrous tissue is liable to result in stricture; when the muscular and serous coats are also involved, the termination is often a mere fibrous cord, a cirrhosis, the result of fibrous hyperplasia whose contraction has closed the whole appendicular canal (*appendicitis obliterans*). From the mucous or submucous tissue the inflammation may involve the muscular and serous coats by the second or third day. Should the contraction be irregular, producing stricture of the canal, the retained secretions on the distal side of the stricture may produce repeated attacks of pain and fever

(appendalgia), to be relieved as soon as the accumulation has distended the walls and provoked muscular contraction sufficient to force the contents through the stricture, or to finally end in ulceration and perforation, which is sooner or later likely to be the case if the accumulated contents do not find its way into the cæcum.

The same pathological condition may be brought about by a flexure of the appendix—that is, if it becomes bent upon itself and perhaps adheres in that position. At the point of flexion the canal is as completely shut off as it is in stricture or by a foreign body. To be sure, recovery may take place after one attack or more; in fact, patients do entirely recover from appendicitis without surgical interference; too often, however, an attack of this disease leaves a pathological volcanic focus, not a pleasant thing to carry around in one's abdominal cavity. The return to a healthy condition of a once pathological appendix is governed to a great extent, no doubt, not by the severity or the pain and fever, but by the extent to which the circulation has been implicated. The condition of the blood supply, and to a less extent the nervous impairment, will determine its power of resistance and its ability to make for health.

Cæcitis.—While, clinically, it is not always possible at the present time to differentiate between appendicitis and cæcitis, pathologically they must not be confounded. The fact that appendicitis is a much more frequent disease is no reason for ignoring the pathology of cæcitis. It is very doubtful whether catarrhal inflammation of the cæcum is so much less frequent than catarrh of the appendix. That ulceration, perforation, and gangrene are less frequent in the cæcum is of course well established. Ulceration and perforation of the cæcum are more likely to be specific—tubercular, syphilitic, typhoidal, etc. Probably few perforations of the cæcum are due to mere lodgement of foreign bodies (a sharp-pointed foreign body may of course readily penetrate the wall), while impaction (typhlitis stercoralis) no doubt is responsible for a few cases.

Paratyphlitis.—To attempt to give all the pathological complications of paratyphlitis and para-appendicitis would be to write the pathological history of each individual case. We may have a matted, adherent, and agglutinated condition in one case, or circumscribed or general peritonitis in another. Again, the contents of the appendix or cæcum may be poured into the abdominal cavity or hemmed in by adhesions, and much may depend upon the size, location, and direction of the abscess. All these pathological conditions may be modified, determined, or governed by the location of the cæcum, location or length of the appendix, free or adherent condition of the appendix, the portion of the appendix or cæcum perforated, as well as, to some extent, by the diathesis and vitality of the patient.

While it is not within the scope of this article to give the anomalies of form and location of the cæcum and appendix, nevertheless a knowledge of these abnormal conditions is necessary in the study of diagnosis, symptoms, and pathology of the disease: of course the abscess in the great majority of cases is primarily intraperitoneal, but no sooner is an abscess formed than it may make toward the surface or above or below Poupart's ligament, or escape into the bladder, vagina, or small

intestines or rectum, or, breaking through the iliac fascia, present in the lumbar region. When the abscess opens into the bladder, vagina, or rectum, it is fair to presume that the position of the cæcum and appendix may be anomalous. The writer has met with all these unfortunate terminations, and saw a case recently of recurring appendicitis where the abscess was discharging through the bladder. Probably 80 per cent. of iliac abscesses originate from purulent appendicitis or paraappendicitis, and are cases of encysted peritonitis or phlegmonous inflammation of the ileo-psoas cellular tissue.

Symptoms.—The group of symptoms which is now generally described as appendicitis was formerly attributed to lesions of the cæcum and designated typhlitis, perityphlitis, and paratyphlitis. The word typhlitis was used when the lesion was diagnosed as inflammation of the mucous membrane of the cæcum. Perityphlitis was the term used when the inflammation involved the muscular and serous coats as well, and paratyphlitis was used to designate inflammation of the connective tissues behind and surrounding the cæcum. It has now been abundantly and definitely proved by hundreds of surgical operations and many post-mortem examinations made in both this country and Europe—more particularly in this country—that this characteristic group of symptoms is the expression of pathological changes, which, for the most part, primarily originate in the appendix and extend to the surrounding serous and connective tissues, involving them in inflammation which is frequently phlegmonous. We say for the most part originated in the appendix, for surgical operations and post-mortem examinations on cases that have been diagnosed as appendicitis have discovered the appendix in a healthy condition, and that the case proved to be one of typhlitis or perityphlitis or paratyphlitis. To be sure, these cases are infrequent, but they do exist. For instance: "The vermiform appendix was found to be normal, while upon the anterior and external surface of the cæcum there were two gangrenous perforations," etc.[1]

No one who has had much experience with appendicitis will attempt to give such a general description of the disease as will apply to all varieties.

Recognizing as we do the great diversity of pathological proceedings and terminations, and that symptoms are but expressions of pathological conditions, it becomes necessary to describe the symptoms of various clinical types as we find them in actual practice.

(1) We will designate the first form, then, as catarrhal or medical appendicitis. In this variety the inflammation confines itself to the mucosa.

(2) The second form we may call mural or parietal appendicitis. This form involves all the coats of the appendix, and may assume a relapsing or fibrinous or cirrhotic tendency and terminate in a fibrinous or cordlike condition of the appendix—*appendicitis obliterans.*

(3) A third variety may be designated as acute or subacute perforating appendicitis. This form might, with great propriety, be called surgical or suppurative appendicitis—not that other forms may not be suppurative or require surgical aid, but because this variety of the disease demands surgical treatment.

[1] McMurtry: *Pacific Med. Journal*, July 7, 1888.

(4) The fourth type we may name periappendicitis, which gives us circumscribed or general peritonitis without perforation of the appendix and non-phlegmonous; and a fifth variety we may desigate as recurrent, which is entirely distinct from relapsing. So protean is this abdominal disease that we are constantly meeting with cases whose symptoms we cannot clinically classify under any one of the above varieties; but even this is not so strange when we take into consideration the anomalies of position and form of the appendix. The same pathological condition of the appendix will manifest itself by entirely different symptoms according to its position.

Among the non-classifiable cases which we occasionally meet is one that commences as an acute colic—enteralgia, so considered and treated as such—and attributed to catching cold or to errors in diet. These attacks may occur at long or short intervals, with quite complete intermissions: each time the attack is attributed to errors of diet or catching cold, and each time yields to treatment for colic. Finally, however, the attack may cease to occur, or, on the other hand, there suddenly develops a well-established attack of appendicitis.

(1) **Catarrhal or Medical Appendicitis.**—This is altogether the simplest form of the disease, and the least likely to require surgical treatment. Medical appendicitis would, therefore, seem quite an appropriate term for this variety of the disease, as distinguishing it from perforative or surgical appendicitis. The attacks may be ushered in suddenly with a slight chill or recurring chilly sensations, with very acute and severe colicky pains concentrating themselves about the umbilicus or perhaps radiating over the whole abdomen, and very often attended with vomiting and fever. The onset of the disease resembles in every way enteralgia, except in most cases there is a temperature. Unlike enteralgia, however, it does not pass off in a few hours, but usually lasts a few days. At the end of twenty-four or forty-eight hours the radiating pains are apt to cease, and from being centred about the umbilicus they become concentrated over the cæcum. Although there is no involvement of the peritoneum, the abdominal muscles are on guard, and give a tenderness and rigidity to the walls over the right iliac region that might be mistaken for peritonitis. It is well known that constipation is sometimes present with catarrhal appendicitis, and that the fecal accumulation may be in the cæcum; this being the case, an elongated doughy tumor, with dulness on percussion and painful to the touch, is readily diagnosed. These cases constituted the stercoral typhlitis and perityphlitis of a few years ago. After a brisk cathartic the tumor disappeared, the pain subsided, and the cure of typhlitis was attributed to the cathartic. After a few days, whether the stercoral tumor be present or not, the symptoms subside and the patient is well, having had no parietal or peritoneal involvement.

Some writers are particular to state that the impaction or stercoral tumor is not the cause of appendicitis, but the result, and due to a paresis of the intestines, the paresis being brought about by the severe abdominal pains. This, however, is far from always being the fact. In many cases the history goes to show that the patient had been constipated for several days perhaps before the sudden onset of the appendalgia, and should the bowels be moved by enema or cathartic a few

hours after the pain sets in, the dried, hard scybalous condition of the fecal matter at once indicates that constipation was of several days' standing and could not have been the result of a few hours' pain. That the stercoral impaction of the cæcum is not necessarily the cause or result of appendicitis is evident from the fact that it is present in only a small percentage of cases. When no impaction and no tumor exists the abdominal parietes may be tender and rigid, and a particularly localized tenderness can usually be made out over the appendix halfway between the umbilicus and the superior spine of the ilium (McBurney's point).

Too much importance must not be attached to this supposed diagnostic point, on account of the anomalies of position and length of the appendix. The term "catarrhal appendicitis" for the past year or two is often applied to cases of acute severe abdominal pains accompanied by vomiting and with or without fever, when all symptoms subside in a few hours. Talamon proposes to call these cases "appendicular colic." The expulsion of a foreign body from the appendix is supposed to be the etiology in most cases of appendicular colic. They are undoubtedly neuralgic, and when the appendix is the seat of the pain I would suggest "appendalgia" or "ecphyadalgia" as a more suitable name and one more in consonance with the genius of the English language.

As a matter of fact, these cases may be appendalgic or enteralgic—that is, an expulsion of a stercoral or other offending body from the appendix, or some indigestible material has irritated the intestinal peripheral nerves.

Mural or Parietal Non-perforating Type.

In this variety we have a true appendicitis—that is, the whole four coats of the appendix are involved in the inflammation. In every case when the walls only are involved, and neither gangrene nor perforating peritonitis takes place, the case remains a mural or parietal appendicitis. The symptoms for the first twenty-four or forty-eight hours may not differ in any way from a catarrhal attack; the vomiting, coated tongue, fever, and pain all correspond; the pain may be radiated over the abdomen or concentrated about the umbilicus (the muscles of the walls are particularly on guard); instead of subsiding after from two to three days, as is usual in catarrhal appendicitis, there is tenderness developed over the right iliac region, and if the cæcum and appendix are in their normal position, the thickened and rodlike feeling of the appendix may mostly be made out by palpation, or a distinct tumor may be felt. In catarrhal appendicitis, there being less tenderness, swelling, and induration of the appendix, it is not so readily felt, though Edebohl and many others claim to locate the position of the healthy appendix by palpation. Morris[1] says: "Physicians must give much more attention to the matter of accurate palpation of the appendix." Physicians who palpate ureters and Fallopian tubes can readily palpate a normal appendix. The tenderness may continue for two or three weeks, with slight exacerbations of pain and slight fever, and finally the patient entirely recovers. In many cases, however, of the mural type, without gangrene or perforation of the

[1] *Lectures on Appendicitis*, pp. 166, 167.

appendix or circumscribed or general peritonitis, an abscess may supervene. On the other hand, relapses are likely to occur, and the case may terminate in *appendicitis obliterans*—cirrhosis or fibrosis of the appendix.

Ribbert of Zurich has recently advanced the notion that with increased age an atrophy of the appendix takes place, and that it becomes shorter—that the histological structure of the walls changes and the lumen is entirely obliterated. He evidently considers that these changes are not the result of previous inflammation, and of course not cirrhotic.

Many of the mural forms that end in appendicular abscess commence in catarrh and become relapsing; each relapse invades more tissue, until from catarrhal the case becomes mural, often stretching over a period of many months or perhaps several years. In these cases there is not a complete intermission, only a remission, of tenderness and freedom from pain; in other words, they are relapsing and not recurrent cases. When the appendix is situated behind the cæcum and colon it is not possible by clinical history or physical examination to differentiate between the catarrhal and mural types. In fact, often it is only possible to even suspect that the appendix is the seat of the disease. That this form of appendicitis may and often does perforate or become gangrenous is as well established as the fact that the catarrhal type may take on an ulcerative or fibrinous condition.

It is not unusual for a patient to have one or more mild attacks of catarrhal appendicitis, when perhaps a third or fourth attack is much more serious and prolonged, and terminates perhaps in abscess or perforation, and possibly death. Instead of subsiding about the third or fourth day, as had previous attacks, the temperature keeps on increasing, while swelling, tenderness, and inflammation develop in the right iliac region, and physical examination reveals a tumor as large or larger than a hen's egg; the first attacks were catarrhal, the latter mural.

Relapsing Appendicitis (Remittent Appendicitis).

This is not a distinct type or variety, but either the catarrhal or mural may assume a relapsing phase. A patient has an attack of catarrhal appendicitis, or perhaps the submucous tissue is also involved; all the active symptoms subside, and the patient is well excepting for some tenderness over the right iliac region. There is evidently a subacute catarrh left to be lighted up by over-exertion, taking cold, or perhaps an error in diet. In the relapse of mural appendicitis, the acute symptoms having subsided and the patient being up and about, there can still be felt, as a rule, a circumscribed induration of the abdominal walls or perhaps a tender tumor or nodule in the right iliac region or a tender and perceptibly thickened cordlike appendix. The same causes that produced a relapse in the catarrhal variety are in operation here.

Acute Perforative or Surgical Appendicitis.

It is to this acute perforative or surgical variety of appendicitis that the disease owes its great present notoriety. This acute surgical type

is often called the fulminative variety. We have only to look back at the pathology of perforative appendicitis to realize that the clinical history of these cases affords a great variety of symptoms, more especially up to the time of perforation; after perforation has taken place each case has many symptoms in common. Although the perforation in every case is due to the presence of intestinal microbes, the time occupied in accomplishing perforation may vary from, say, thirty-six hours to as many days. The sufferings of the patient during the time may be constant and intense or may be paroxysmal, or the process may be painless.

The clinical history of each case up to the time of perforation is in strict accordance with its ètiology or pathology. Most of the cases of perforation which are caused by obstruction of the appendicular opening, and probably some of the cases of stricture of the canal, give a clinical history of great pain for a few days at least. This may be called the appendalgic period. The cases of perforation that result from complete strangulation of the appendicular artery by twisting, etc. are quite free from pain until the perforation has taken place. The sudden intense pain, collapse, violent peritonitis, phlegmonous inflammation, or the death of the patient, as the case may be, follows close upon the perforation. The patient has no warning of the impending intra-abdominal storm. The perforation in these cases is gangrenous or necrotic, while the perforation in the obstructive type is for the most part ulcerative—simply a slower death of the part. Acute perforative appendicitis does not necessarily mean that the perforation takes place with the first attack; it implies the rapid breaking down of the wall. It may be a relapsing or recurrent case, more especially when it is obstructive.

In following the clinical history of these acute perforative cases we divide them into perforative painful cases and perforative painless cases. In the former the period of pain before perforation may be from twenty-four hours to six days. The perforation, as a rule, takes place within the six days. The patient is suddenly seized with severe colicky pains of a cramping, twisting nature, extending over the whole abdomen and accompanied by severe vomiting or vomiturition, and not infrequently high temperature; the pain and cramps are sometimes quite confined to the right side, so much so that appendalgia has been diagnosed as renal colic. But more often they radiate over the whole abdomen or may circle about the umbilicus; occasionally the pain is felt more to the left side, owing no doubt to an anomalous position or length of the appendix. In exceptional cases the perforating period manifests itself by a constant dull, deep, heavy ache. The fever in these cases is not usually high and the vomiting is not frequent. In a few cases, more especially in children, there is catarrhal diarrhœa preceding or accompanying the first pains, but more frequently the bowels are constipated. In the cases where constipation precedes the attack unless the impaction is in the cæcum it is in all likelihood purely incidental. Anorexia, coated tongue, thoracic breathing, rapid pulse, and rigid and sensitive abdominal walls furnish the clinical picture of this acute perforative period.

The Second Stage.—We recognize the exacerbation of symptoms, which are suddenly ushered in by the perforation of the appendicular wall and the escape of the contents of the appendix into the peritoneal

cavity, as the second stage of this type of appendicitis. We have seen that the perforation may appear as early as twenty-four hours or the first stage may be of several days' duration. The new exacerbation of pain is usually intense; the suffering is so intolerable that the patient makes no effort to locate it; in fact, the agony is too often so severe that the patient's attention cannot be directed to any one particularly tender location. The physician of experience soon realizes that he has on his hands a case of diffused peritonitis of intense type. The patient assumes the dorsal decubitus position, with his knees drawn up, his head thrown a little back, so that the chin is somewhat elevated; the breathing becomes rapid, shallow, and thoracic; the abdominal walls are rigid and extremely tender to pressure, the weight of the bed-clothes being often intolerable; vomiting is too often an early symptom and one that adds to the patient's terrible distress. Every effort to vomit causes an agonizing expression, and a look of appeal to the physician for relief that is not likely soon to be forgotten. The temperature usually ranges from about 101° to 102° F., though sometimes it is subnormal, but occasionally reaches 105° F. The pulse is frequent and fine or thready. Obstinate constipation is the rule, due no doubt to a paralysis of the muscular structures of the intestines, more particularly of the colon. The urine generally contains some albumin, and always indican, and is scanty and high colored. Frequent micturition with cystospasmus is a distressing feature of many cases, while cystoplegia is the exception. The oliguria and albuminuria are by most writers attributed to the elimination of ptomaïnes by the kidneys which have been absorbed by the blood from the intestinal tract, or the elimination of microbes which the blood has absorbed from the abdominal cavity, or to the heart weakness or want of arterial force. In many of my own cases the oliguria was certainly due to the inability of the stomach to retain fluids. No fluid being absorbed from the stomach, very little urine is eliminated. And I can see no reason why such a marked change in the functional activity of the kidneys—from eliminating fifty or sixty ounces of urine daily to, say, five or six ounces or even less—should not disturb and derange the tubular and glomerular epithelium, and hence the albumin. The frequent micturition and tenesmus may be the result of pericystitis or a chemical change in the condensed urine. The rigidity of the abdominal walls, especially in strong men, is sometimes extreme. The walls are very painful to the slightest touch, and the tenseness, rigidity, and tenderness preclude all possibility of obtaining any information of the abdominal contents by palpation or percussion. There is often no great tympanites with this intense rigidity in men, but in women who have borne children, whose abdominal walls are weak, the tympanitis is frequently extreme. After a few hours of suffering we may expect to see the peritoneal facies and pinched expression, dull, sunken eyes, cold, clammy extremities, dry lips and tongue, feeble, thready pulse, shallow thoracic breathing, with moaning expiration, hiccough, and death.

At least 80 per cent. of these cases die within the week after perforation. Perforation of the stomach and intestines gives about the same clinical history. The immediate shock following perforation seems much less in some cases than in others, and the inflammation of the peritoneum which follows varies in rapidity and intensity in dif-

ferent individuals. In peritonitis, as in other septic diseases—diphtheria, for instance—the patient may die on the second or third day. Death may be due to the virulence of the poison absorbed or the greater amount absorbed, or to the peculiar susceptibility of the patient to the particular poison. Undoubtedly many individuals seem to possess a weak hold on life; occasionally one weathers the first week's storm only to die later, apparently from sheer exhaustion.

Acute Parietal Appendicitis, with Circumscribed or General Peritonitis, without Perforation or Suppuration.

The group of symptoms which we now diagnose as acute appendicitis with circumscribed peritonitis that sometimes becomes general, and that terminates in resolution, was a few years ago called perityphlitis; the probability is that an occasional case is that of perityphlitis without involvement of the appendix. A purely catarrhal appendicitis will sometimes very closely assimilate this mural type. The tenderness of the right iliac region and an apparent swelling may be mistaken for circumscribed peritonitis. A careful examination, however, reveals the fact that the abdominal wall in catarrhal appendicitis has not the rigid and indurated feeling that it has in peritonitis. The pain is more continuous and less colicky than in catarrh, and the temperature is more steady, though it may not be very high. In circumscribed peritonitis the rigidity and induration and tenderness of the abdominal walls over the swelling are well marked. The right leg (if not both legs) is drawn up, more or less fixed, and its motion is painful. This variety of appendicitis may be either relapsing or recurrent. A patient of mine, a young man about eighteen, had in about one year and a half three well-marked attacks of recurrent appendicitis, and with each a circumscribed peritonitis. It is now nearly two years since his last attack. He determinedly refused an operation.

The inflammation in these cases is no doubt strictly fibrinous. The chances of phlegmonous inflammation, a purulent collection ending in resolution, is scarcely possible and surely not probable. We use the word "resolution" in its proper sense, for a purulent collection may of course be evacuated into the cæcum, for instance, and the patient get well.

The DIAGNOSIS of this form of appendicitis depends entirely upon the symptoms of the second or fibrinous stage—that is, the stage of peritoneal involvement. The symptoms of the first stage cannot be differentiated from appendalgia or the catarrhal form. The difference in the duration of the two forms is characteristic, the catarrhal lasting but a few days, while the fibrinous exudative variety is seldom fairly convalescent in less than three weeks.

Recurrent Intermittent Appendicitis.

Neither recurrent nor relapsing (remittent) appendicitis is, strictly speaking, entitled to be considered a distinct variety or form of the disease. The difference between recurrent and remittent appendicitis is similar to intermittent and remittent fever: the terms remittent and intermittent appendicitis are pathologically more correct and clinically

just as understandable, and therefore preferable to the terms relapsing and recurrent. Either catarrhal or mural appendicitis may become relapsing—*i. e.* chronic; that is, between the acute paroxysmal attacks the inflammation almost, but not altogether, subsides. If following the attack of appendicitis the tenderness and swelling entirely disappear, a subsequent attack is called recurrent. This clinical distinction is useful and in a way justifiable, but may not be pathologically correct. We strongly suspect that the inflammation does not entirely subside, though the tenderness and swelling do; if all trace of the inflammation subsides and the patient is entirely well after his first attack of appendicitis, why should it predispose him to a second attack? In intermittent fever, while the patient is apparently well for twenty-four or forty-eight hours between the chills, no one for a moment supposes that he is during this intermission free from the bacillus malariæ. In recurrent (intermittent) appendicitis it is not probable that the bacillus coli communis and other intestinal micro-organisms are entirely inactive in either the retained secretions or in the walls of the appendix during the intermission of all tenderness and swelling.

There is nothing necessarily peculiar in the clinical history of an intermittent or remittent attack to distinguish it from a preceding one. There is no definite period of time between the attacks, and either the relapsing or recurrent may follow the preceding attack in a few weeks or a few months: some writers would have it that in return cases there is a predisposing condition existing. To sustain their opinion they are forced to the supposition, however, that the intervals between the attacks were accompanied by complete restoration to health.

Pus; Abscess; Phlegmonous Appendicitis.

The character, location, and quantity of the pus in appendicular abscess vary greatly in accordance with the position of the appendix, its adhesion, its length, and the diathesis of the patient. The pus is seldom what the old writers call laudable; usually it is a thin, sero-purulent, floccular, and yellowish green liquid, the odor of which is extremely offensive. The abscess not infrequently contains offensive smelling gas and fecal matter, or perhaps the scybalum, coprolith, or other foreign body whose presence in the appendix had given rise to the inflammation, and which had escaped from the appendix through the perforation.

Location.—The purulent accumulation must necessarily be intra- or extraperitoneal. When the appendix is free in the abdominal cavity the abscess is of course intraperitoneal. When the appendix is given off from the posterior cæcal wall, ascends behind the cæcum and ascending colon, and is adherent to or surrounded by the cellular tissue of that region, the appendicular abscess will be extraperitoneal and may invade the lumbar region. Many of the obscure cases of lumbar abscess, as well as some of the supposed perinephritic abscesses, are no doubt appendicular. Occasionally we find an abscess in the anterior abdominal wall extraperitoneal; pathologically, it is a phlegmonous inflammation of the subserous (peritoneal) cellular tissue. Such an abscess occurred in the case of a physician upon whom the writer operated. As a curious

coincidence, the writer had operated for appendicitis upon three children only a few months before for the same physician. There are probably other conditions of the appendix which favor extraperitoneal abscess; for instance, some cases of pelvic inflammations (pelvic cellulitis) are the result of inflammations of a misplaced and adherent appendix. The inward and downward direction of the appendix may in case of its inflammation give rise to a pelvic peritonitis and abscesses that can be felt *per rectum* or *per vaginam* and behind the bladder. These are the cases, no doubt, that evacuate themselves through the rectum, bladder, or vagina. The size of the abscess or quantity of pus varies with each case from a small pus collection the size of a walnut to that of a quart measure.

Complications and Sequelæ of Appendicitis.

Gangrene.—Gangrene and perforation are complications, inasmuch as neither of them is a necessary result of appendicitis. A gangrenous termination to appendicitis is usually the result of an impediment or an obstruction to the appendicular circulation from a torsion or twist or strain upon the artery, or it may be the result of the involvement of the vessel in the inflammation—thrombosis. The phlebitis or endarteritis, or both perhaps, completely occlude the nutrient vessel. When the nutrient artery is a terminal one, as is the case in the appendix, gangrene may be expected as a frequent complication. Gangrene has been found to have already taken place within twelve or fifteen hours after the clinical history would indicate the commencement of the attack. The clinical history of these cases is surely misleading, the thrombosis having probably preceded by many hours the appendalgia and fever.

While the appendix is not highly vitalized (no vestigiary organ is) the organ will not become gangrenous by twelve hours' deprivation of nourishment. Gangrene sometimes invades the neighboring tissue, bloodvessels, etc.

Perforation.—Perforation is a very frequent complication of appendicitis, an obstruction in the cæcal opening causing an accumulation of the appendicular secretions, which affords an excellent opportunity for the generation of pathogenic bacteria which are doubtless the destructive agents. Occlusion of the appendicular canal may occur from an impacted foreign body or from stricture the result of inflammation of the mucous and submucous membranes. In the case of impaction the consequent venous stasis or passive congestion adds to the chances of perforation.

Peritonitis.—So fatal a disease as peritonitis must necessarily be a serious complication, and when an accompaniment of appendicitis it becomes extremely dangerous. An appendicular peritonitis is necessarily secondary and septic, and when diffuse, whether phlegmonous or not, offers an enormous absorbing surface which is likely to seriously tax the strongest constitution. Fortunately, appendicular peritonitis is oftener circumscribed than diffused.

Stomach.—Persistent vomiting is not only a most distressing, but a dangerous, complication of appendicitis. The reflex vomiting which

for the most part accompanies the onset of the disease, though painful, is not dangerous. Determined and persistent vomiting in appendicular peritonitis is an alarming symptom, and in most cases, no doubt, is caused by gastric peritonitis, the involvement of the serous investments of the stomach.

Hiccough.—Hiccough is particularly painful and exhausting in appendicular peritonitis, and as a rule only accompanies the last stage of the disease.

Liver complications are much to be dreaded. Pylephlebitis and hepatic abscess constitute the most formidable complications. Fortunately, they are becoming less frequent, with every prospect of the number of cases being still further reduced. It is only in the latter stage of the disease, when the mesenteric veins, the highways and byways to the portal circulation, become thrombic and embolic, that there is danger of pylephlebitis or hepatic abscess. Not only are cases of liver complications becoming less frequent, but all the complications and sequelæ which result from chronic appendicitis are less numerous in consequence of timely surgical treatment.

Lungs and Pleura.—It is safe to say that the lungs are very seldom involved. All the thoracic complications or sequelæ of appendicitis are secondary. I have seen pneumonia and empyema as the result of both the appendicular and hepatic and diaphragmatic peritonitis, as well as from hepatic suppurations. In exceptional cases the appendicular hepatic abscess or empyema breaks down the lung tissue and is discharged through the bronchi. Septic pneumonia may occur from iliac phlebitis, and septic emboli from the thrombic veins act as pneumonic foci. Pulmonary tuberculosis may be complicated with tubercular appendicitis.

Heart.—I have never met with a case of pericarditis from appendicular, hepatic, or diaphragmatic peritonitis, but cases of the kind have been reported.

Phlebitis.—While inflammation of the mesenteric veins is frequent, and of the veins of the liver (pylephlebitis) is not very common, thrombosis of the iliac vein is quite a rare complication.

Hemorrhage.—Both the iliac veins and arteries may possibly become involved in the gangrenous process that sometimes extends to the surrounding tissue from a gangrenous appendix; a fatal hemorrhage is the result. The same accident may occur when there exists a varicose condition of the mesentery or ovarian veins.

Bowels.—The most frequent intestinal complication is constipation, which in a large percentage of cases seems to be the result of a paralysis of the muscular structure. An occasional case of obstinate constipation or obstruction occurs from an inflamed, adherent, and contracted appendix, which is wound around the intestine. Even a circumscribed gangrene of the intestinal wall may occur from an adherent gangrenous appendix. The perforation of an abscess into the bowels or rectum is an occasional occurrence. The cæcum is the portion of the bowel that is most frequently the subject of this complication. This latter accident happens more especially when the abscess is situated behind the cæcum and ascending colon. Acute appendicitis has been found in both inguinal and hernial sacs.

Bladder.—It is rather a rare occurrence for an appendicular abscess to be discharged through the bladder. This complication occurs almost exclusively in women, and most probably only when the appendix is situated in the pelvis. A few months ago the writer was called to see a case where a large quantity of pus and fecal matter was being discharged from the bladder. On investigation the case was found to be one of recurrent appendicitis. The young woman, aged eighteen, had had two previous attacks, one of which had resulted in a lumbar abscess, and on the other occasion the abscess was evacuated through the bowels. She absolutely refused all surgical aid. The pus and fecal matter ceased to appear in the urine in about ten days. This might be considered a rather remarkable case—three attacks of appendicitis, each being phlegmonous with a large collection of pus. The first discharged through the lumbar region, the second through the bowel, the third and last discharged through the bladder, and the young woman now enjoys, apparently, a complete intermission with fair health, but presents a tuberculous appearance. In the case of lumbar abscess it is always, of course, possible that it may have been the result of perinephritis or some spinal disease. The clinical history of each case of lumbar abscess demands a very careful investigation.

Tuberculosis and Syphilis.—Tubercular and syphilitic ulceration of the mucosa of the appendix is a frequent occurrence, and probably is, for the most part, secondary to tubercular and syphilitic ulceration of the cæcum or some other portion of the intestinal tract.

Pregnancy.—Cases of appendicitis are occasionally reported as complications of pregnancy or the puerperal state. When such cases occur they are usually coincident and not complications. A woman might have appendicitis while carrying a uterine fibroid or an ovarian tumor. A patient of the writer's while the subject of softening of the brain had an attack of appendicitis, and a gentleman not long since had an attack of appendicitis when convalescing from a gunshot wound of the shoulder. Such cases are purely incidental.

Fallopian Tubes.—We have already seen that the appendix is liable to occupy a position in the pelvis, especially in women. It has been found attached to the Fallopian tubes, to become gangrenous in this position, and thus to implicate the tube in the gangrenous process; and pyosalpinx sometimes has its origin in the inflammation of an adherent appendix.

Diagnosis.—One gathers from the vast amount of literature that is being published on appendicitis that it is often a very obscure disease and extremely difficult of diagnosis. If a physician knew nothing of the pathology and symptoms of pneumonia, he would be unable to diagnose the disease, and would no doubt think the group of symptoms was the expression of an obscure affection. There are no doubt general practitioners in active work to-day who do not possess a work on the practice of medicine or surgery, or even a dictionary, that contains the word "appendicitis." Many general practitioners, it must be remembered, are also prone to be negligent in regard to current medical literature. To these, and these only, is appendicitis an obscure disease and difficult to diagnose. It is only in very exceptional cases that the diagnosis of appendicitis presents difficulties. To the physi-

cians and surgeons of any considerable medical centre, who keep abreast of the medical literature of the day, who attend county, State, and national medical societies, the diagnosis of appendicitis is not as difficult, is less obscure, and less likely to be overlooked than is either tubular or intertubular nephritis. One would also gather from the profuse surgical literature on appendicitis in the medical journals that it requires a surgeon to diagnose and treat every case of appendicitis. Except in the large cities the general practitioner is obliged to diagnose and treat his surgical as well as his medical cases, and in very many instances he is as capable a surgeon as he is physician. As not more than 5 to 10 per cent. of deaths occur in appendicitis that are not operated upon, it would seem, even in the large cities, that a physician might be able to treat the most of them without surgical assistance; and we presume it will be readily granted that a good physician is as capable a diagnostician for internal diseases, at least, as a good surgeon, yet, according to much of the surgical literature on appendicitis, such would seem not to be the case. "I have seen the surgeon forced to defer operation in appendicitis because the opinion of the majority of the medical attendants was opposed to such a procedure, they holding the case to be one of typhoid fever."[1] At most not more than 5 per cent. of the cases of appendicitis are very difficult to diagnose, and this may be said for almost any other disease; and any one who has had much experience with the diagnosis of abdominal diseases knows that nothing short of exploratory incision will clear up the diagnosis of some cases, and this applies to diseases of every organ in the abdominal cavity. Twenty years of abdominal surgery has taught the writer to reserve his diagnosis in some cases of abdominal disease until he gets his hand into the cavity; even then he is occasionally reminded that it requires more than the sense of touch and the macroscopic appearance of the pathological condition to diagnose the exact pathology of the case. As a rule, it is the complications that obscure appendicitis and make the diagnosis difficult. There are practitioners who find none of the difficulty that so many encounter in the diagnosis of this protean abdominal disease. "We do not need exploratory incisions to determine whether a patient has appendicitis or not."[2] "The diagnosis can and should be made in a few minutes."[3] In 90 per cent. of the cases, at least, of appendicitis the diagnosis is very readily made by the previous history of the case, the acuteness of the attack, the character and location of the pain, the circumscription of the tenderness, the development of dulness or tumor over the cæcal region, the rigidity and resistance of the abdominal walls, the temperature, the wiry abdominal pulse, the decubitus of the patient, the character of the breathing (short and thoracic), the age, sex, habits, and occupation of the patient, and the accompaniment of nausea and vomiting, with the information obtained by a rectal or vaginal examination, which makes the picture unique, the diagnosis unmistakable. The nature and location of the pain are characteristic. The pain is sudden and colicky, radiating over the lower two thirds of the abdomen or circling about the umbilicus. Soon, however, the radiating pain becomes less, and, from being more

[1] Deaver on *Appendicitis*, p. 94. [2] Morris, p. 164.
[3] Deaver on *Appendicitis*, p. 123.

severe about the umbilicus, concentrates itself over the ilio-cæcal region. The pain is now more constant and less violent and colicky. As it confines itself more particularly to the right iliac region, palpation demonstrates that this location is distended, extremely tender, rigid, and resistant. The stress laid upon point tenderness is not without its value.

Though the tenderness is not by any means, in every case, on a line from the anterior superior spinal process of the ilium to the umbilicus (McBurney), a careful palpation does generally elicit a particularly tender point, perhaps at the base of the appendix, or may be at the extremity or over its *anomalous* position. In pelvic appendicitis a tender point in most cases can be detected by vaginal or rectal examination. When the appendix points upward the tender point is usually in the location of the gall-bladder. In parietal appendicitis—at least after the acute stage of the inflammation has in a measure subsided—by a careful examination the swollen and enlarged appendix can generally be felt, unless the abdominal wall is too rigid and tender and too thick. It is well to bear in mind that palpation and percussion must be cautiously done when gangrene or recent perforation of the appendix is suspected, and under no circumstances must palpation be done in a jerky, punching manner: the palmar surface of the fingers of one hand should be placed flatly on the abdomen over the cæcal region, and steady, firm pressure made while the hand is drawn from near the umbilicus to the crest of the ilium. The fingers must be educated to feel what is beneath the abdominal wall with as much accuracy as the blind man educates his fingers to read raised letters. It is sometimes well to first locate the ascending colon above the most rigid and tumefied portion of the wall, and by following the colon downward the cæcum can be distinctly outlined, when the swollen, tender, and enlarged appendix can quite readily be located by palpation and percussion when its position is normal. In a case under treatment at present on the third day the appendix could be outlined less than halfway from the crest of the ilium to the umbilicus, and extending two and a half inches almost perpendicularly from a little above Poupart's ligament. A decided distention of this region is also manifest with dulness even before a circumscribed peritonitis is established. As the disease advances and the adhesions form the fulness becomes more pronounced; the abdominal distention and tympanitis are not extreme in the absence of general peritonitis, and not always pronounced when it is diffused.

With the involvement of the visceral layer of the peritoneum and with intestinal paresis tympanites is extreme in appendicitis. In distention from impaction the rigidity and tenderness are absent and borborygmus is usual. As a result, the patient assumes the dorsal decubitus position, and by the second or third day draws up the right leg, and occasionally finds relief by drawing up both legs. It would seem to be traditional that the drawing up of the right knee more particularly indicates that the appendix is given off posteriorly, and its inflammation involves the cellular tissues of the ilio-psoas. As a rule, the knees are flexed when the peritoneum becomes involved. In the absence of diffused peritonitis the left leg is moved freely. The right leg is flexed and the movements are accompanied with pain whenever

the inflammation extends down into the iliac fossa. The respiration is usually hurried from the first, and becomes distinctly thoracic, with lessened abdominal breathing. There is an anxious and depressed look, and the chin is generally elevated; 80 per cent. of the cases will occur between the ages of ten and fifty years, and will be found four times oftener in men than in women. Habits and occupations are responsible for the greater frequency of the disease in men than in women. The nausea and vomiting in a great measure cease with the first stage of the disease, and are evidently reflex—probably leucomaïnic irritation of the sympathetic nerves, as the vomiting does not seem to be induced by or depend upon the contents of the stomach. Persistent vomiting later in the disease would indicate involvement of the serous coat of the stomach. It is the complicated cases and the diseases that may be mistaken for appendicitis that give rise to diagnostic difficulties. Talamon gives hepatic colic, nephritic colic, indigestion, and entero-colitis as the conditions most likely to be confounded with or mistaken for appendicitis. To be sure, in any of the above conditions it may require care to differentiate them from appendicitis. The practitioner who has had some experience with abdominal surgery has no doubt met with abdominal diseases that are much more difficult to differentiate from appendicitis than those mentioned by Talamon. To Talamon's list we will add a few more diseases: Acute perforating ulcer of the stomach or duodenum or perforation of the ileum or cæcum or gall bladder; cholocystitis or intussusception, especially ileo-cæcal; internal strangulation, hernia, volvulus, impaction of fæces or foreign bodies, typhlitis and perityphlitis; movable kidney that has become inflamed and adherent behind the cæcum; floating kidney, and diseases of the Fallopian tubes, extra-uterine pregnancy, hæmatocele, hip-joint disease, lumbar abscess, and typhoid fever. Some of these, at least, are of sufficient importance to warrant a consideration in detail.

Liver and Gall Bladder.—Neither pylephlebitis nor abscess of the liver is likely to be mistaken for acute appendicitis, but when they are secondary to appendicitis the primary disease (appendicitis) may very readily be overlooked, unless the history of the case is very carefully traced.

Hepatic Colic (Cholocystalgia).—Great care may be required to differentiate this condition from appendicitis and appendalgia. They have many symptoms in common, such as pain, its sudden commencement, its paroxysmal and radiating character, and nausea and vomiting. In hepatic colic the pain is felt more in the upper half of the abdomen, and gives more of a diaphragmatic restricted feeling and concentrates less about the umbilicus. Usually before twenty-four hours the pain in hepatic colic is localized over the gall-bladder and above a horizontal line drawn through the umbilicus, and jaundice begins to manifest itself. The vomiting is more continuous, and with the jaundice the urine becomes porter-like in color. In appendicitis the tender point is located below the level of the umbilicus and near the crest of the ilium, and occupies the right iliac fossa. The temperature in hepatic colic is very irregular, especially if the attack be prolonged, often reaching 104° or 105° F., to drop down in a few hours to normal or subnormal. In appendicitis the temperature is not so high and is

more steady. There is an absence of jaundice in appendicitis, and the urine is not colored with bile.

Gall Bladder.—Rupture of the gall bladder simulates rupture of the appendix even more closely than does cholocystalgia. An exact diagnosis is impossible when one is called to a patient in great abdominal pain, in a condition of collapse, with anxious and sunken expression, severe vomiting, and no circumscribed appendalgic peritonitis, no jaundice. There are cases of rupture of the appendix without any history of appendicitis, and rupture of the gall bladder may occur where there is no jaundice or previous hepatic colic. In the majority of cases, however, previous to the rupture of any of these organs there is an unmistakable clinical history that will enable a diagnosis to be made.

Kidney.—An attack of renal colic of the right kidney on account of the location of the pain might possibly be mistaken for appendalgia. In nephralgia the pain very generally shoots down the line of the ureter or is often felt in the testicle. There often is hyperæsthesia of the bladder, with cystospasms and occasionally hæmaturia.

Floating Kidney.—A patient with a floating kidney is often the subject of attacks of nephralgia, which may have many symptoms in common with appendalgia ; the kidney-shaped movable tumor should establish the diagnosis.

Movable Kidney.—A movable right kidney could only be mistaken for an appendicitis when inflamed and fixed in its displaced position, but the clinical history of the case, with an intelligent interpretation of the objective symptoms, should enable one to make a differential diagnosis. An abscess high up behind the ascending colon, resulting from perforation of a posterior cæcal appendix which points upward, might very readily be mistaken for abscess of the liver or suppuration of the gall bladder or paranephritic abscess or nephrosis or tuberculosis of kidney and ureter or psoas abscess. Unless there is permanent obstruction to the ureter, pus will be present in the urine in pyonephrosis and tubercular kidney. It must be remembered, however, that especially in tubercular kidney the lumen of the tubercular ureter is lessened, and for several consecutive days there may be nothing escaping from the diseased kidney ; in the mean time the healthy kidney is excreting normal urine. It is not unusual that the urine must be examined for several days before it is found to contain pus. Great difficulty will sometimes be encountered in differentiating psoas abscess. The rigidity and resistance of the abdominal wall are absent, as is also the enlarged and tender appendix. In doubtful cases as to the presence of pus the diagnostic value of the needle and aspirator must not be forgotten. By resorting to the use of the needle no doubt the operator would gain the contempt of some experts, but might confirm his diagnosis and save a patient from needless operation, and save his life. Experts who have so dogmatically condemned the use of the exploratory puncture do not realize how disastrous it would be to the general country practitioner to subject a patient to an operation for appendicitis or abscess and have to acknowledge that he had made a mistake in his diagnosis. With proper aseptic precautions a carefully made exploratory puncture can scarcely ever be harmful, and may often be of great assistance in establishing a diagnosis and in determining the necessity of operative

measures. An ordinary hypodermic syringe with a rather large-sized needle will generally answer the purpose. Notwithstanding all that has been said by experts against exploratory puncture, it is not only justifiable, but often helpful to the general practitioner, who very frequently is unable to procure either consultation or assistance, but must deal with diseases and conditions with which he is not very familiar and in which he has had perhaps little experience.

Differentiation.

Appendicitis.	Cholocystalgia.	Nephralgia.
Pain.—Colicky, radiating, over lower two thirds of abdomen, circulating about umbilicus, and becoming fixed in right iliac fossa. Develops tender point (McBurney's).	Radiating over upper half of abdomen and toward right shoulder; develops tenderness over gall bladder.	Radiating less over abdomen, but down the ureter to testicle and head of penis, and often irritates rectum. Develops tenderness over kidney in lumbar region.
Vomiting is usual, but not extreme.	Is a pronounced feature, and is persistent.	Is pronounced, but not so persistent.
Bladder and testicle symptoms absent.	Bladder and testicle symptoms absent.	Bladder hyperæsthesia; often cystospasmus.
Urine, normal.	May contain bile.	May contain blood and mucus.
Jaundice, absent.	Present.	Absent.

The above differentiation stands for the rule; there are exceptions. When the appendix, for instance, points upward and the inflammation is at the apex, the pain is in the upper portion of the abdomen, with great tenderness in the region of the gall bladder or over the right kidney. When the appendix is in the pelvis, appendicitis may give pain on the left side of the median line, with irritability of the bladder or perhaps cystitis.

Stomach.—It is barely possible that a severe attack of gastralgia might be mistaken for appendalgia. Care should be taken with the history of the case and attention paid to the subjective symptoms. The pain and tenderness should be located over the stomach. The pain does not radiate over the whole abdomen, as in appendicitis. As for the round acute perforating ulcer of the stomach, it is quite impossible to differentiate it from sudden perforation of the appendix; that is, in the case of appendicitis where the perforation takes place without being preceded by appendalgia or peritonitic symptoms.

Intestines.—Intussusception, more especially ileo-cæcal, gives some symptoms in common with appendicitis—viz. the location of the pain and fulness or tumor and vomiting. The tenesmus with diarrhœal discharges containing blood and mucus would, of course, make for intussusception, and the latter disease is most frequent in infancy and childhood, a period of life in which appendicitis is rather uncommon.

Hernia (*internal, abdominal*) may readily be confounded with appendicitis. The suddenness of the attack, the pain, the vomiting, the peritonitis that so often accompanies it, and the obstruction of the bowels, are all symptoms in common. In hernia the vomiting is more persistent, and soon becomes stercoraceous, while the tympanites is more pronounced.

Volvulus also may be mistaken for appendicitis; in both of these

diseases it may be impossible to differentiate them from appendicitis, at least during the first twenty-four to thirty-six hours of the attack. If by this time there is no indication of pain and tenderness becoming located in the right iliac fossa, and no tender point developed, there is a strong suspicion that the case may not be appendicitis, and an exploratory incision may be necessary to make a diagnosis. The symptoms of perforating ulcer of the duodenum or ileum in no way differ from perforating ulcers of the stomach or rupture of the gall bladder, unless the history of the case previous to the rupture would indicate the particular accident. Exploratory incision is the only means of making an exact diagnosis.

Typhlitis, peri- and *paratyphlitis*, are manifested by much the same group of symptoms as has been described for diseases of the appendix. In typhlitis the tenderness is perhaps not so circumscribed; there is no McBurney point. On pressure the pain seems nearer the surface and nearer the crest of the ilium, and the cæcum is more often found impacted—that is, a stercoral tumor is more often present. It is always of the greatest importance to cultivate observation and the sense of touch, and exercise the best judgment, in order to differentiate diseases. But when dealing with a case that might be either perforation of the stomach or bowels or gall bladder or appendix, or internal abdominal hernia or invagination, a prompt laparotomy is of much more importance to the patient than an astute guess at differential diagnosis: when in doubt, operate.

Coxitis.—For one who has never seen a case of appendicitis or paratyphlitis mistaken for a case of coxitis it may be difficult to imagine its possibility. In scrofulous children, more especially, the mistake may occur, as one is always on the lookout for coxitis, and might naturally fall into the mistake. My own experience furnishes one such case of appendicitis. The boy was under treatment for hip-joint disease by a distinguished surgeon. Dispensing with his weights and pulleys, the evacuation of a perityphlitic abscess resulted in the boy's complete recovery. That a para-appendicitis or typhlitis or appendicitis should produce pain in the hip or knee is not surprising, since both the obturator and anterior crural nerves descend through the fibres of the psoas muscle, and both send branches to the hip-joint and knee-joint.

Extra-uterine Pregnancy, Pelvic Hæmatocele, Salpingitis and Pyosalpinx, Pelvic Appendicitis.—It is only in sudden rupture of an ovisac that this condition (extra-uterine pregnancy) might be mistaken for perforation in appendicitis. The profound collapse that usually follows the rupture of the ovisac, on account of the hemorrhage which mostly follows, makes against appendicitis. When a history can be obtained there have been symptoms of pregnancy previous to the collapse, but the puerperal age is to be considered.

Pelvic Hæmatocele.—This condition has many symptoms in common with pelvic appendicitis. The symptoms of loss of blood, the sudden appearance of tumor, the characteristic feel of a tumor, etc. must assist in the differentiation of the disease. But much depends upon the situation and size of the blood-clot, whether intra- or extraperitoneal or a hæmatosalpinx. The sudden appearance of a retro-uterine tumor, with symptoms of internal hemorrhage, should not be mistaken. Slow

hemorrhage from varicose veins of the broad ligament might cause the diagnostician very great difficulties. In most cases of hæmatocele there is a history of uterine or ovarian disease.

Pelvic Appendicitis.—While appendicitis occurs four times more often in men than in women, the appendix is found in the pelvis much more often in women than in men. The broad, flaring, shallow pelvis of the woman offers facilities for the more ready descent of the appendix. Forcing down the abdominal organs by tight lacing, especially where the cæcum is loaded (and women are very subject to constipation), is another important factor. The weakening of the abdominal walls by pregnancy, as well as the sudden contracting down of the uterus after delivery from its abdominal position during pregnancy into the pelvis, also must have an influence in displacing the appendix downward. It is fortunate that appendicitis is not so frequent in women as in men: what with the present chances to lose her ovaries, she would be at great disadvantage indeed if in this appendage too the frailty was with the woman. Pelvic appendicitis is of the greatest interest to every practitioner who has at all to do with the diseases of the female pelvic organs.

Tubes and Ovaries.—The appendix, once in the pelvis, is liable to become attached to the Fallopian tubes or ovaries. An inflamed appendix may adhere to the tubes and result in a salpingitis or a pyosalpinx. On the other hand, an infected tube may communicate disease to an adherent appendix. Finding the group of symptoms characteristic of salpingitis on the right side, it is not always possible by the pain or character or shape of the tumor to exclude the possibility of an inflamed adherent appendix. Though inflammation of the left tube is much more frequent than that of the right when the tenderness, inflammation, and tumefaction are on the right, if these symptoms were preceded by a gonorrhœa, for instance, it is fair to presume the case is one of salpingitis; if preceded by colicky and intestinal disturbances and no history of tubo-uterine disease, there would be a strong presumption in favor of pelvic appendicitis. In ovaritis or salpingitis there are not the rigidity and resistance to the abdominal wall that obtain in appendicitis. A suppurating right ovarian cyst offers even more diagnostic difficulties than salpingitis or pyosalpinx. Extensive experience with abdominal diseases teaches that, notwithstanding the greatest possible care, a diagnosis must be made in many cases with mental reservation, lest a laparotomy or autopsy reverses the diagnosis.

Typhoid Fever.—To mistake the cæcal tenderness of typhoid fever for appendicitis and to open the abdomen could only occur to one of that class of specialists who possesses a strong desire to operate and who lacks a knowledge of the clinical history of diseases that even every specialist should possess. A careful analysis of the symptoms, with the clinical history and the microscopic examination of the fæces, should enable one to differentiate between typhoid fever and appendicitis. Nevertheless, specialists in abdominal surgery have operated on cases of typhoid fever for appendicitis. In one case that came to my knowledge the diagnosis was made after the operation by a microscopic examination of the fæces; the bacillus Eberth was obtained by culture.

Prognosis.—The friends of a patient are usually more anxious and

much more inquisitive and annoying to the medical attendant about the prognosis of the attack than the patient. They would not at all be satisfied in the case of appendicitis with the statement that about 90 per cent. of all the cases of appendicitis get well; they have no interest whatever in the other 99 cases; their anxiety is for the case in hand. In giving a prognosis in an individual case of appendicitis the medical attendant must take into consideration the stage of the disease at the time, the severity of the attack, the nature of the complications, if any, and the possibility of complications. A few points at least are well established that will apply in the prognosis of such cases:

1. If surgical treatment is to be instituted, the earlier in the history of the disease that the operation is done the more favorable will be the prognosis.

2. After appendicular suppurative peritonitis is established the prognosis is bad, with or without surgical treatment.

3. When medical treatment is being entirely relied upon, the favorableness of the prognosis is not always in direct proportion to the apparent mildness of the attack.

We have already seen that during the progress of gangrene or perforation of the appendix the patient may have very little pain or fever (page 293).

4. The complications of pylephlebitis, abscess of the liver, or suppurative pleurisy render the prognosis absolutely unfavorable. Even in the mildest cases of catarrhal appendicitis an exacerbation of symptoms is liable to occur, when the case may assume formidable proportions.

Parietal appendicitis (even non-suppurative) is always serious when accompanied with circumscribed peritonitis; when the peritonitis becomes general the prognosis is very unfavorable. Most of these cases, however, if non-suppurative, get well without surgical treatment, but are liable to relapse.

Suppuration in every form, whether intra- or extraperitoneal, adds to the gravity of the case, and the prognosis is almost hopeless without surgical treatment. I am of the opinion, however, that the gravity of suppurative peritonitis is over-estimated. Only four weeks ago I was called in consultation in a case of appendicitis, and assisted Dr. Winslow Anderson with the operation. There was pus in the peritoneal cavity, with gangrene of the appendix, and also a portion of adherent omentum, and a necrotic condition of the serous coating of the ileum, to which the appendix and omentum were adherent. The appendix and the gangrenous portion of the omentum were removed, and 25 per cent. solution of peroxide of hydrogen was applied to the suppurating surface, and the abdominal cavity was well washed out with sterilized water; a drainage tube was left in, and the patient went out of the hospital well in three and a half weeks.

Occasionally, however, the pus escapes externally or safely through the intestines or through the vagina, or it may be absorbed. A case illustrating the absorption of pus: Thirteen years ago I attended a boy for appendicitis with circumscribed peritonitis and abscess. The father refused to allow an operation; the pus was absorbed; the boy was well for ten years, when he had another attack without peritonitis, and within

the past year he has had three more attacks without peritonitis. Having arrived at that age, "twenty, when as duteous sons we wish our fathers were more wise," he concluded to part with his appendix. I operated May 10, 1897: the appendix consisted of a stump $1\frac{1}{4}$ inches long; there had been a gangrenous destruction of the apex when he suffered from the attack thirteen years ago; it was firmly adherent to the cæcum; there was stricture at the orifice; the cavity was quite distended with mucus, and the membrane was softened. The last catarrhal attack was three weeks before the operation.

In my own experience one patient recovered after the abscess had escaped through the bladder. On account of the great tendency to relapse the prognosis may still be unfavorable, as far as the ultimate recovery of the patient is concerned, though he may have entirely recovered from the attack. This applies even to the mildest form of the catarrhal variety.

In the surgical treatment of appendicitis, aside from the stage and gravity of the case, the prognosis will depend to a great extent upon the skill and experience of the operator. It is much to be regretted that the abdominal cavity is constantly being invaded by those who have neither experience nor training in such work; in consequence thereof valuable lives are frequently sacrificed. In the colicky or appendalgic variety the subsidence of the pain and fever before the expiration of forty-eight hours from the onset is a favorable omen, and unless the case relapses within the next forty-eight hours the chances for complete recovery are excellent. An attack of appendicitis during pregnancy is unfavorable, as abortion and death are apt to result.

More than half the deaths from appendicitis occur within the first eight days.

Treatment.—Much extreme writing on the treatment of appendicitis has appeared in medical journals of late, or perhaps we might more properly say writers in medical journals on the treatment of appendicitis have been expressing very extreme views on the subject. One surgeon declares that appendicitis is a purely surgical disease, and that all the physicians in the country and all the medicine in the drug-stores are worse than useless; they only delay surgical treatment and thereby jeopardize the life of the patient. Another says that at the very first appendicular pain a surgeon should be summoned. Another says there must be no hesitation; operate in every case within the first twenty-four hours (one instance, probably, where hesitation on the part of the surgeon would prove as disastrous to the man as to the woman). Again, another taunts the physician with having done nothing for the treatment of appendicitis—that surgeons have done everything; its present treatment is a triumph for surgery. The physician (the extreme type, of course) retorts by saying that appendicitis has done a great deal for the surgeons, and as for the surgically treated patient, he has lost his appendix, paid for the operation, and his life was endangered or perhaps lost; that more patients die when treated surgically than when treated medically; that "meddlesome appendicitis is bad." He (the physician) is at a loss to know why appendicitis should be called a purely surgical disease, when if all the cases of appendicitis, taken as they come, should be treated medically and by the average general practi-

tioner, not more than 10 per cent. would die. Guttmann shows that of 100 cases of typhlitis and perityphlitis treated medically only 4 deaths occurred. We have no means of knowing how many of these hundred would have died had they been operated upon by the same general practitioners; probably from 20 to 30 per cent. It is not at all certain what the percentage of deaths would be should every case of appendicitis be operated upon early; there are surgeons who do not hesitate to assert that the surgical treatment would give the fewer deaths. We believe that in the very near future physicians and surgeons will regain their mental poise and will treat appendicitis with the same good sense and judgment, and with the same conservative regard for the life and interest of a patient, as they do every other disease.

"On the other hand, it is advocated to operate as soon as the diagnosis of appendicitis has been made, whatever its grade of severity. Between these extreme views held by those who favor operative measures a middle course is usually available. A case demanding operation within twenty-four hours from the beginning of the attack is exceptional."[1]

It is the physicians and surgeons who take middle ground in the treatment of appendicitis to whom we must look to save every patient from being subjected to a serious operation on the one hand, and on the other to prevent those who should be operated upon from being allowed to die without timely surgical aid. An extremist is seldom right on any subject. With a better knowledge of the etiology, pathology, and clinical history, and the addition of some experience and common sense, it would seem that appendicitis will in the near future be treated as rationally as any other disease.

"'Perityphlitis belongs to the surgeon' has been until lately an assertion defended with emphasis by many surgeons, but which has never received the assent of the general practitioner, and never will. According to the experience of general practice and the statistical results of Sahli, Renvers, Guttmann, Leyden, Fürbringer, Hollander, Rotter, and the majority of French physicians, from 90 to 91 per cent. of all cases of perityphlitis, taken in the widest sense, recover without any operation. It would therefore smack of insanity to subject every case of perityphlitis to the uncertainties of an operation."[2]

It is true that there is a lack of definite knowledge on many points in the treatment of appendicitis which, if cleared up, would put the treatment on a safer and more rational footing than obtains at present. For instance, we can only approximate the average death rate of appendicitis under purely medical treatment. Let us call it 10 per cent. But we are unfortunate in not being able to know with any degree of certainty, before it is too late, which are the 10 of each 100 that should have been operated upon early. We are at present entirely at sea as to what the percentage of deaths would be if every person with appendicitis or supposed appendicitis were operated upon within the first twenty-four hours of the attack, as advocated by so many surgeons. "The diagnosis can and should be made in a few minutes,

[1] Fowler: Hare's *Practical Therapeutics*, p. 598, vol. iv., 1897.
[2] Ewald: *Twentieth Century Practice*, vol. ix. p. 170.

and the operation should follow as soon as possible."[1] The percentage would probably be small if every operation could be conducted under the very best hygienic and aseptic surroundings and circumstances and in the hands of skilled operators; which is, of course, absolutely impossible. Hundreds of patients must be treated for appendicitis under the worst hygienic surroundings and the most pronounced septic conditions, and by medical men unskilled and inexperienced in surgery. Surely the writers who so strenuously and unqualifiedly urge surgical treatment in every case of appendicitis cannot keep these facts in mind: they should at least remember that circumstances govern cases.

Again, it might be well to inquire if every case diagnosticated as appendicitis should be operated upon within the first twenty-four hours, what percentage would be found not to have the disease—say 10 per cent. in experienced hands and 30 in inexperienced. And what compensation would these unfortunates receive? Of course, when the abdomen was open the appendix might be removed, and to be immune thereafter from appendicitis would be a consideration. And in case any of them die, their friends could be told that they died that others might live. A glorious example for their children if they had any! It is also important to inquire what percentage of surgical cases might be left with ventral hernia. Ramm[2] "states that it is not infrequent to find an apparently healthy appendix at operations in cases in which the clinical symptoms have been those of appendicitis." This is quite a common experience.

Nothing more absurd could be proposed for the treatment of appendicitis than that every case diagnosticated as such should be operated upon within the first twenty-four hours, which, every physician and surgeon of experience should know, is before the disease can be diagnosticated with any certainty in many cases. It is not possible at present to fix the day or hour of the disease when an operation for appendicitis is advisable. The proper time to operate after the diagnosis is established and the proper case for operation must be determined by the medical man or men in charge of the particular case. Not to operate unnecessarily, and not to postpone operation until it is too late, will often tax the judgment of the most experienced. How early in the disease and what percentage of cases should be operated upon should depend largely upon the surroundings of the patient and the skill and experience of the operator. Perhaps the best rule that can be formulated for operating is—Always operate when serious doubt arises as to the necessity for an operation. That skilled and experienced surgeons are justified in operating earlier and oftener than unskilled and inexperienced operators goes without saying. While surgeons call appendicitis a surgical disease, under some of the circumstances already mentioned the surgical treatment should be strictly confined to opening an abscess when fluctuation can be distinctly made out; and inexperienced practitioners are fully justified in using carefully the exploratory needle to diagnosticate the presence of pus.

A patient with severe colic is likely to send for a physician to be relieved of pain. To give the patient a measure of relief, to make a

[1] Deaver on *Appendicitis*, p. 123.
[2] Gould: *Year-Book*, 1897, p. 170.

diagnosis as soon as it is possible, and to inquire into the condition of the bowels are the first duties of the physician. The abdomen should be carefully examined for stercoral impaction; if present in the sigmoid or rectum, it should be removed at once by enema—a quart of warm water with an ounce of glycerin or vinegar or a teaspoonful of salt, etc. If in the cæcum or in a case of simple constipation, a teaspoonful of castor oil, repeated every half hour until the bowels operate, is the best and safest of all laxatives in this disease; no other medicine will so thoroughly empty the bowel with as little irritation to the mucous membrane. The oil may be given in ʒj capsules. Small doses of calomel, one eighth to one fourth of a grain, repeated every half hour or every hour in case the oil is not retained, or one large dose, say of ten to twenty grains, will sometimes check vomiting and act as an efficient and mild laxative, or a teaspoonful dose every half hour of a saturated solution of sulphate of magnesia until the bowels are freed from all offending material. Unfortunately, salts sometimes produce liquid passages without emptying the bowels of all impacted fecal matter. It is as important to move the bowels freely with mild laxatives or enema as it is to avoid active purgation. Mild laxatives assist in relieving the pain by clearing the intestines of all irritating material and reducing the congestion of the bloodvessels. Active purgation adds fuel to the fire. The bowels, once freely relieved by mild laxatives, should subsequently be kept open by enema every day, consisting of a quart of warm water with one half a teaspoonful of lysol or two teaspoonfuls of boric acid or a tablespoonful of turpentine emulsion, etc.; it not only prevents intestinal fermentation, but relieves the bowels from accumulated gases. Hot bottles to the feet and hot applications over the abdomen, with five drops of tincture of aconite in a tablespoonful of whiskey and four tablespoonfuls of warm water by injection, afford a measure of relief from pain in incipient appendicitis without masking the objective symptoms, which is a matter of much importance in the early diagnosis of the disease. Half a teaspoonful of compound elixir of chloroform or thirty drops of Hoffman's anodyne in a teaspoonful of syrup of codeine is to be preferred to any considerable dose of morphine or laudanum when an opiate must be given. Fortunately, patients at the present time are likely to escape the torture of blisters, tincture of iodine, thermo-cautery, or other relics of barbarous therapeutics. At the commencement of circumscribed peritonitis a dozen leeches may be applied or the ice-coil may be substituted. Leeching is of no possible benefit in catarrhal appendicitis, nor is the ice-coil or bag; in fact, cold generally increases the pain.

With due deference to the many able and distinguished writers who oppose the administration of laxative medicine in appendicitis, I most emphatically advise laxatives (castor oil or calomel to be preferred) sufficient to very thoroughly unload the bowels. And I am just as emphatic in my belief that opium is an objectionable medicine, inasmuch as it certainly increases the always present difficulties of differentiating the gangrenous cases. While it allays the patient's pain and the physician's anxiety, the fuselike appendix smoulders. The narcotic state increases the difficulties of interpreting the pathological progress of the disease as expressed by the symptoms. And it is always easier

to postpone a seemingly needed operation if the patient is not suffering, and too often in appendicitis delays are dangerous.

Too much care cannot be exercised in regard to diet. Whether it be a catarrhal case of three days or a parietal case of three weeks, no solid food should be allowed until the patient is well on in convalescence, but diet should be confined strictly to cocoa, strained gruel, broths made with rice or barley, and strained peptonized milk or whey or buttermilk, milk with half a teaspoonful of salt and a large teaspoonful of malted milk to each goblet stirred and sipped slowly. It is important that the patient should be kept in bed and not allowed to rise under any consideration. The patient should be made to understand the danger of hasty or violent movements; he should allow himself to be assisted in turning or moving in bed. A gangrenous appendix may give way with very little effort on the part of the patient, or an abscess-wall may rupture. Rest as nearly absolute as possible must be enjoined.

To sum up: To evacuate the bowels early by enema or by mild laxatives by the mouth; to apply hot applications to the feet and over the abdomen; to relieve the pain, preferably with tincture of aconite and whiskey in water by injection, or compound elixir of chloroform, or Hoffman's anodyne; to be exceeding careful with the diet; to confine the patient strictly to bed; and to exercise the greatest care and best judgment in procuring the most skilful surgical aid at the proper time for the proper surgical cases,—is the rational treatment for appendicitis. A strictly antiseptic cœliotomy for gangrenous or suppurative appendicitis, skilfully performed by an experienced abdominal surgeon, in its life-saving results is one of the most necessary, brilliant, and justifiable operations in the whole range of modern surgery.

The following case illustrates the extreme surgical view of the treatment for appendicitis, and the clinical history of a case of fibrinous, non-purulent, non-perforative, parietal appendicitis with its medical treatment:

On Thursday, November 29, 1894, I was called to see a patient whom I found with characteristic appendicular circumscribed peritonitis; temperature 102° F., pulse 110; extreme tympanites; breathing thoracic; both knees drawn up; tongue very much furred; and an expression of anxiety and distress. The tender point was well defined on a line from the umbilicus to the inferior spinous process, and only one third of the way from the spine to the umbilicus. He had been taken ill at half-past 2 A. M. Tuesday, the 27th, fifty-six hours before, with intense abdominal pain and vomiting.

His wife had given him hot water and whiskey, hot ginger tea, and had applied hot applications over bowels, all with very little relief. Soon after daylight he sent for a doctor who lived in the neighborhood, who, though a general practitioner, evidently had extreme surgical views on the treatment of appendicitis. He told the patient that he had an attack of appendicitis, and unless he submitted to an operation at once he would not take charge of the case. The patient, supposing that he was only suffering from colic and knowing nothing of appendicitis, absolutely refused to be "cut open for colic." The doctor left, and left the patient's mind as perturbed as his bowels. The patient took a

bottle of fluid citrate of magnesia, and, finding his pain worse by the afternoon, sent for another neighboring physician, who prescribed for him. Next morning, November 29th, the patient told the doctor that he now realized that he was a very ill man, and wished to place himself under the care of a physician whom he and his family knew by reputation. Fifty-six hours after the commencement of the attack I found him as above stated. I explained to him the risks he would have to take if not operated upon—that the case might terminate in perforation or gangrene or abscess. He was a lawyer and an intelligent man. He said, "If you will stand by me and give me relief, and not operate until the necessity for an operation is absolutely demanded, I will take the risk." He was ordered hot applications to the abdomen, warmth to the feet, and the following prescription:

℞. Spiritus ætheris compositi,
Elixir chloroformi compositi, āā. fʒij;
Syrupi tolutani, q. s. ad fʒij.—M.
Sig. A teaspoonful every hour or two according to pain.

An enema of warm water was also given. His condition remained about the same for the next four days, when the temperature fell to 100° F., and the tenderness and rigidity of the walls were less. From this time until December 20th the swollen and tender appendix could be made out distinctly. After about the 25th (Christmas), though the tenderness and rigidity had pretty well disappeared, it was barely possible to any longer feel the appendix. While it was felt distinctly, it could be traced for 2.5 inches perpendicularly from Poupart's ligament and 1.5 inches from the crest of the ilium. The two-ounce mixture was repeated once, and part of the second bottle was taken, which was all the medicine given, the bowels having been kept open by the enema. The temperature was normal after the 15th. December 28, 1894, four weeks and three days from the inception of the attack, he was up and walking, and would have been out but for the rain, and he seemed perfectly well. The hot applications to the bowels were discontinued on the fifteenth day of the disease.

From the history of this attack it is more than probable that the first appendalgic symptoms were the result of strain, as the attack was sudden and occurred immediately after he had cohabited.

When these fibrinous, non-purulent cases are the result of the lodgement of a foreign body, it is doubtful if they ever terminate in resolution while the offending material remains in the appendix. The prognosis of appendicitis from strain or injury, as a rule, should be more favorable than from lodgement of foreign bodies.

The differentiation of the medical from the surgical cases demands the most careful scrutiny of each case. An appendicitis commencing suddenly in the night after several hours' rest in bed would naturally suggest the lodgement of a foreign body. It was only by careful inquiry that the possible cause was elicited in this case. For my own part, I have not the slightest doubt that with increased experience it will be possible to differentiate the gangrenous cases that are now the *bête noir* of the medical attendant.

INTESTINAL PARASITES.

By GEORGE DOCK, M. D.

Protozoa.

A number of species belonging to various classes and orders of the protozoa occur as parasites of man. Some are pathogenic; others are only occasional parasites; still others, commensals, living with, but not at the expense of, the host, sometimes perhaps even being of advantage to him. Some are of great interest and importance, and from the history of their discovery we have reason to think that hitherto undiscovered causes of disease may be found among other species, members of these low orders of the animal kingdom. All these organisms are unicellular and of comparatively simple structure, yet many of them have developed organs which make them appear at first glance highly complicated. One of the most important and one of the lowest of these organisms, the amœba coli, is described in detail in a separate chapter. (See Dysentery, Vol. I. p. 364 et seq.)

The bulk of the body of a protozoön is made up of protoplasm or "sarcode," a finely granular-looking, gelatinous substance. Unless there are special organs (skeletal) which hinder it, the protoplasm is capable of amœboid motion. It also is capable of differentiation into two layers, an "endosarc" and ectosarc" or "endoplasm" and "ectoplasm." These two layers usually have different physical characteristics, the endosarc being more granular or less hyaline; and different functions, the ectosarc being the organ of motion, of prehension, and excretion, and the endosarc the digestive organ. The ectosarc in many species is capable of forming pseudopods, as seen so commonly in amœbæ; it also produces in various forms temporary or permanent whiplike organs of motion. If short, these are termed cilia; if long, flagella. Occasionally a mouth, œsophagus, and other (excretory) organs are present. There is always a nucleus, varying greatly in size, form, and affinity to dyes in various species. Reproduction is carried on by division, mitotic or more frequently amitotic, by budding, or by spore-formation. Division may also take place in an encysted stage or after conjugation. In many species the mode of reproduction is not known.

The parasitic protozoa may be endocellular parasites, as in the case of the malarial hematozoön, or extracellular. In most cases their origin is unknown, though it is most probable that they are derived from forms living in water or in or on plants. Among the most important reasons for our imperfect knowledge of these parasites are—the small size of many of them, about that of red blood corpuscles; the fact that they either have no characteristic form or easily lose it after leaving the host;

finally, our inability to cultivate them as we do bacteria. As in the beginning of bacteriology, harm is being done by enthusiastic but unskilled observers, but we cannot doubt that eventually much progress will be made in the investigation of these forms.

Among the rhizopods the amœba is the only genus of interest as a parasite of man. The next class, the sporozoa, contains a number of parasites of great interest in comparative pathology. The order coccidia is chiefly interesting on account of its connection with the changes which follow the infection of the rabbit's liver by that parasite—changes early looked on as carcinomatous, and even now claimed by some as of that kind.

The most important species is *coccidium oviforme* (Leuckart). It appears as an oval body, 0.033–0.040 mm. long, 0.015–0.028 mm. broad, with a double membrane. The outer membrane is delicate and easily lost, and is perhaps the remains of the cell in which the body grew. The inner membrane is highly refracting, with a double contour. The body itself appears as a coarsely granular mass, later becoming round, with a clear spot in the middle in which lies the nucleus. Reproduction takes place usually by the formation of the so-called sickle-shaped spores, though R. Pfeiffer has described a process of endogenous sporulation. In rabbits the spores are set free in the stomach.

Coccidia are best known in man, as in lower animals, as parasites of the liver or biliary apparatus. Cases in which the intestines have been affected have been reported by Eimer (c. perforans), Kjellberg (c. perforans or bigeminum), and by Railliet and Lucet. Grassi and Rivolta have described the occurrence of coccidia in human fæces, but in these cases it is impossible to know whether the parasites came from the intestines or the liver. In the cases of Railliet and Lucet, affecting a mother and child, there was chronic diarrhœa. Diarrhœa was also present in a case of coccidiosis of the liver and spleen in a woman reported by Silcock. There were lesions in the intestines, but it is not clear that these contained coccidia.[1]

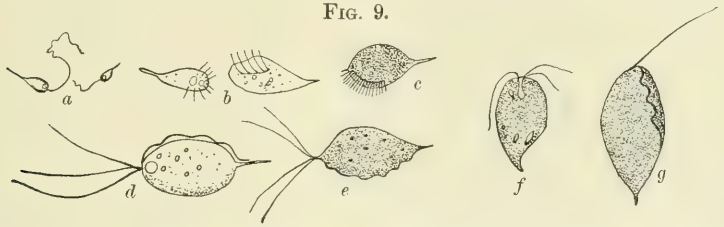
A number of parasites belonging to the class of infusoria and subclass flagellata have been found in the human intestines or fæces. Organisms of this class are unicellular, usually bilaterally symmetrical, and with but slight tendency to change of form. They are distinguished by the presence of lashlike processes, either short (cilia) or long (flagella). The species and genera are not yet accurately defined. A very common form is the one first described by Davaine and named by him *cercomonas hominis*. This is a parasite of oval or spindle form, with a single long flagellum on the broader end and a sharp or taillike process at the other end. An undulating membrane has not as yet been demonstrated. The bodies are from 0.003 to 0.012 mm. long, though specimens longer than 0.006 mm. are rare. The broad end usually shows with low powers a bright spot which has been taken for the nucleus, but the actual nucleus has not been definitely demonstrated. The parasites are characterized by the lively and erratic motion they exhibit in a liquid medium. At times they appear to become fast to neighboring objects and to keep up an active fluttering motion. These parasites have been found in the stomach contents (Osler, Destrée) in cases of

[1] *Transactions of the Path. Soc. London*, xli. p. 320.

chronic gastritis, and once by the writer in a case of cancer. They have been found very often in the stools in a large number of diseases, such as typhoid fever, dysentery, and other diarrhœal diseases, and even in health. Cunningham, Grassi, and Schuberg believe they are constant and harmless parasites of the human intestines. In the body of an executed felon Müller found cercomonads in the jejunum thickly covering the mucous membrane, without evidences of disease of the latter. Following Schuberg, I have found them occasionally in the watery stools of persons apparently healthy, after the administration of Carlsbad salt. As Perroncito claims, however, that a species of cercomonas produces a fatal disease in guinea-pigs, the human parasite deserves further study. It is easily found in stools freshly passed by putting a small bit of the watery part on a slide and examining with a moderately high power. The lively motion makes the parasite easy to recognize.

In the opinion of the writer the form just mentioned is to be distinguished from other flagellate parasites which have been described under various names, such as *trichomonas intestinalis* (Leuckart), *monocercomonas*

FIG. 9.



Flagellates from the intestine, after various observers. (See *American Journal of the Medical Sciences*, Jan., 1896, p. 1); *a*, cercomonas hominis (Davaine); *b*, trichomonas int. (Marchand); *c*, cercomonas int. (Zunker); *d*, trichomonas hominis (Grassi); *e*, the same after May; *f* and *g*, after Roos.

hominis (Grassi), *cercomonas coli hominis* (May), etc. It is probable that most or all of these belong to one genus and species, which at present can conveniently be termed *trichomonas intestinalis*. This parasite is somewhat larger than cercomonas, being usually from 0.010 to 0.015 mm. long. It has the same general shape, but has a number (four?) of flagella and an undulating membrane extending from the insertion of the flagella backward along the side of the body. There is a long oval nucleus. Small vacuoles can be seen, but there is no pulsating vesicle. Mouth, œsophagus, and other internal organs cannot be demonstrated, though a mouthlike opening or peristome may sometimes be present.

Trichomonas intestinalis has been found in fæces in a number of diseases, with or without diarrhœa, and the prevailing opinion is that it is non-pathogenic. May, however, thought it caused a chronic enteritis in one case, and Epstein believes it causes a severe diarrhœa in infants.[1] As to this form, as well as cercomonas, it must be remembered that although it may exist in the body without causing inconvenience, it may, when present in large numbers, at times cause actual disease. This possibility should be borne in mind in practice, and when discovered the parasites should be expelled by the administration of cathartics, aided if necessary by anthelmintics.

[1] See résumé by the author: "Trichomonas as a Parasite of Man," *American Journal of the Medical Sciences*, Jan., 1896.

These organisms can be found by examining fæces in a recent condition, and can be recognized by the motion of their flagella and undulating membranes. Staining is unsatisfactory.

Lamblia intestinalis, also called *cercomonas intestinalis* (Lambl, 1859) or *megastoma entericum* (Grassi), is a common intestinal parasite and apparently non-pathogenic. It is oval or pear-shaped, with a hollow or excavation in the under and anterior part, the edges of the hollow being contractile. Four pairs of flagella rise from the ventral aspect of the body and are directed backward. The protoplasm is soft. There is a dumbbell-shaped nucleus in the anterior part. The body measures from 0.010 to 0.016 mm. in length, 0.005 to 0.0075 mm. in width.

The sub-class ciliata is represented in human pathology by *balantidium* (*paramœcium*) *coli*, discovered by Malmsten in the pus from a chronic rectal ulcer. This is an oval parasite, 0.070 to 0.100 mm. long, 0.050 to 0.070 mm. wide. At the anterior end is a funnel-shaped mouth ending in a short œsophagus. The endosarc and ectosarc are distinct. The body has parallel longitudinal striations; the surface is covered with short cilia. The nucleus is reniform. There are contractile vesicles. Reproduction is effected by transverse segmentation, as well as by conjugation and the formation of cysts. Balantidium has been observed most frequently in persons with chronic diarrhœa or dysentery, and has been found especially in Northern Europe. It has also been found in Italy and China. The parasites occur especially in the cæcum, appendix, sigmoid flexure, and other parts of the colon. They are found in the mucus rather than in the fæces. Leuckart found that balantidium coli is common in the rectum of hogs, so that it seems probable that the encysted parasites are derived from these animals. Grassi and Calandruccio, however, were not able to infect themselves with balantidium cysts from the hog.

Balantidium is affected by acids, so that in case of infection enemata of tannic acid or of weak acetic acid should be used, after cleansing the colon by copious injections of water or salt water (.7 per cent.).

Trematodes.

The trematodes are chiefly important for their infection of the biliary apparatus of sheep (*distomum hepaticum*) and of the abdominal and pelvic veins in man (*bilharzia hæmatobia*), but certain species are also found in the intestines, lungs, and other organs, and when in the biliary apparatus or in the intestines may appear in the fæces.

The trematodes, plathelminthes, or flukes are bilaterally symmetrical parasites, usually flat, tongue-, or leaf-shaped, or elliptical, or in some species cylindrical.

The life history of the flukes is extremely interesting, but cannot be described in detail here. The forms which occur in man become sexually mature in that host, having been ingested with food or water.

Amphistomum hominis.—This is a short (5 to 8 mm. long, 3 to 4 mm. broad) reddish worm, with a round or trumpet-shaped sucker at the anterior extremity. The eggs are oval, 0.150 mm. long, 0.072 mm. broad, and have a lid. This worm has been found in but two cases, in

the cæcum and colon, in large numbers, but apparently only as an accidental parasite. The intestine in the cases observed showed marks like leech-bites.

Distomum hepaticum, *fasciola hepatica*, the liver-fluke, is the cause of the "rot" in sheep and has been found in man in the bile-ducts, the portal vein and intestine, and occasionally in subcutaneous abscesses. It is flat, tongue-shaped, brownish on the sides and yellow in the middle, the latter being modified when the intestine is full by the contents of the latter; from 25 to 32 mm. long and 8 to 13 mm. wide. The surface, especially on the back, is covered with scaly spines. At the end of the conical head is a small round ("oral") sucker, behind this a "ventral" sucker, and between the two the genital aperture. The eggs, brown or yellow, are usually very numerous. They measure 0.130 to 0.145 mm. in length, 0.070 to 0.090 mm. in width, and have lids. When the parasites are passed by the intestines they can be recognized without difficulty. The eggs may be passed by the bowel alone, and if found might lead to a diagnosis, though the exact microscopic diagnosis is by no means easy.

The occurrence of *distomum hepaticum* in the intestines probably never comes under observation unless the parasites are present in the biliary apparatus. If the parasites or their eggs are recognized in the fæces, cathartics and anthelmintics are indicated.

Distomum Buski, *distomum crassum*, is the largest of the flukes. It measures 4 to 8.5 cm. in length, 1.4 to 2 cm. in width; is oval, with a smooth surface; the two suckers are close together. The eggs are somewhat smaller than those of distomum hepaticum. This worm has been found in the fæces of native Chinese or East Indians, or rarely in other persons who had long resided in those countries.

Distomum Rathouisi is a small, long oval fluke, 25 mm. long, 16 mm. wide.

Distomum heterophyes is 1 to 1.5 mm. long, 0.7 mm. wide, oval, pointed in front, of reddish color, with chitinous spines on the surface.

Distomum lanceolatum is 8 to 10 mm. long, 1.5 to 2.5 mm. wide, long, narrow, pointed in front, broader and pointed behind. The eggs are thick-skinned, dark brown, 0.038 to 0.045 mm. long and 0.022 to 0.080 mm. wide.

All these forms and their eggs have occasionally been found in the fæces or intestines, where, however, they produce no distinct symptoms.

CESTODES.

Tape-worms get their name from the long, flat, tape-like body conspicuous in most species. They consist essentially of a head or *scolex;* a neck, which at first is narrow and smooth, but gradually becomes wider and shows transverse striations; and the body or *strobila*, made up of distinct segments or *proglottides.*

The segments become more mature as they become more distant from the head. They are hermaphroditic, and capable, when mature, of leading for a short time an independent existence.

There are two views as to the nature of the mature tape-worm. According to the older one, the tape-worm is a colony, each proglottis

being the equivalent of the scolex and formed from it by a budding process. According to the other view, the adult worm is an individual in which a reduplication of certain organs has taken place. There are facts in biology which lend support to both views.

The tape-worm retains its place in the intestine by means of the suckers, assisted, if "armed," by the hooklets on the scolex. The worm receives its nourishment by imbibition from the nutritive fluids in which it lies in the intestine.

Tape-worms are covered by a more or less thick membrane, penetrated by numerous pores and occasionally having hairlike processes on it. This membrane is variously looked on as a basement membrane derived from the mesoderm or as an ectodermal epithelium which has lost its cell-boundaries and nuclei. The hooklets are derived from the outer layer, and vary in size and form in different species.

The parenchyma of the tape-worm is complex in its structure. The details need not be mentioned here, but the presence of numerous calcareous bodies in it deserves notice on account of their striking appearance in specimens examined microscopically. These are oval or ellipsoid, and composed of an organic basis and lime salts, especially carbonate of lime. They are looked on as calcified parenchyma cells.

The muscular system of tape-worms is quite extensive. Just beneath the outer covering is a thin layer of fibres; beneath this longitudinal and circular or transverse fibres in strong bands; and within these the dorso-ventral fibres.

Fig. 10.

Head of tænia saginata (Eichhorst).

The suckers are differentiations of the muscular system which occur only on the scolex and form important organs in the classification of the parasites. In some species they are round or disk-like, in others grooves. Another muscular structure is the "rostellum," which is present on the armed tape-worms and serves to give motion to the hooklets. In unarmed cestodes the rostellum is either absent or appears as a sucker.

The nervous system of the tape-worm consists essentially of two ganglia in the scolex, joined by transverse fibres, and peripheral nerves. The latter give fibres to the suckers and rostellum, and, passing back as lateral nerves, give branches to the various organs in the proglottides.

The tape-worm has no alimentary canal, but possesses a somewhat complicated excretory organ or system, formerly spoken of as the water-vascular system. This begins in so-called terminal or renal cells with a system of capillary and collecting tubes, which end in (usually) four longitudinal canals, joined at the back part of each proglottis by a transverse canal. At the point where this joins the longitudinal canal there is a valve which prevents the contents from being forced toward the head during the contraction of the body. In young or perfect cestodes the longitudinal canals end in a single one, usually terminating in a small contractile vesicle. When the worm grows older and the oldest proglottis is cast off, the canals open inde-

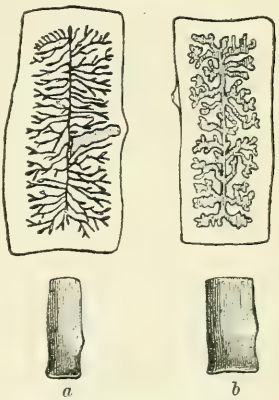
pendently. The fluid in the canals is usually clear and watery. It contains substances apparently allied to xanthin and guanin.

In the youngest proglottides no genital organs are present. The male organs are formed first. At the time of sexual maturity the generative organs often make up the bulk of the proglottis. The uterus, filled with thick-shelled eggs, gives a dark color to the segment, and from its form often gives an important clue to the diagnosis of the species. As the segments grow older the generative organs become atrophied, the uterus being the last to undergo degeneration. The genital apertures are sometimes on the sides, sometimes on the surface (ventral usually), of the segments. The testes, usually numerous, are scattered through the parenchyma. Their ducts unite to form a vas deferens, which passes out in a spiral manner to the genital sinus, where it ends in the "cirrus," an intromittent organ in some species furnished with barbed hooks. This lies in the cirrus-sac. The female genital apparatus varies in arrangement in different species. There is usually a bilateral ovary placed at the posterior end of the proglottis. The oviduct soon after leaving the ovary unites with the yolk-duct, derived from the *vitellarium*, a peculiar organ found in other flat worms, consisting of a number of glands scattered through the parenchyma. At the point of junction of the two ducts the oviduct is enlarged, and at this point receives the secretion from numerous "shell-glands." From this point two tubes arise—one the vagina, which extends to the genital sinus, the other the uterus. This latter either opens on the exterior or is blind externally, forming a convoluted or branched system of tubes. In some cases a uterus in the ordinary sense is absent, the eggs being impregnated and ripening in the ovary. When the uterus has no external orifice the eggs are only freed by the rupture of the proglottis, so that the absence of eggs in fæces does not prove the non-existence of a tape-worm in the intestine.

Fig. 11.

Proglottis of bothriocephalus latus; natural size, and enlarged three times (after Eichhorst).

Fig. 12.



Proglottides of (*a*) tænia saginata and (*b*) t. solium; natural size, and enlarged three times to show arrangement of uterus (after Leuckart).

Development of the Tape-worm.—The impregnation of the eggs takes place either by the intromission of the cirrus into the vagina of the same proglottis, or copulation can take place between the respective organs of two proglottides of the same or two different worms. Even without intromission the semen can flow from the cirrus into the vagina after closure of the genital pore by a contraction of its muscular wall. The eggs are impregnated before they receive their outer layers, the yolk and shell. The yolk is either cellular (bothriocephalus) or clear and albuminous (tænia). The eggs differ in appearance in different species.

The development of the eggs takes place either in the uterus or out-

side of it after spontaneous rupture of that organ or after digestion in another animal. The embryo, or "oncosphere," also called a "six-hooked embryo," is a small spherical body with six chitinous hooklets arranged in pairs. The embryos do not develop further in the parent worm nor in the outer world, but, at least in the case of the commonest human tape-worms, always require the intervention of another host. The latter acquires the embryos either directly, as in the case of dogs and many other animals, or indirectly from contaminated food or water. The species of the host is not a matter of indifference: certain embryos can only develop in certain animals. So the embryo of the tænia solium develops as a rule only in hogs, that of tænia saginata in cattle; that of tænia cucumerina, a parasite of dogs and cats, only in parasitic insects of dogs, cats, etc. Sometimes young animals are easily infected by a given embryo; older ones of the same species are not.

Fig. 13.

a *b* *c*

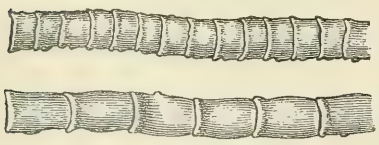
Eggs of (*a*) t. saginata; (*b*) t. solium; (*c*) bothriocephalus latus; × 300 (after Eichhorst).

When the embryos are swallowed they penetrate the walls of the stomach or intestines, and wander or are carried with the blood into some organ, occasionally a distant one, as the brain or eye. For a time the embryo remains quiet. Its hooklets are lost, and it then enters its larval stage, and is known as a scolex or cysticercus, the precise characters of which vary in different species. In the simplest form the scolex resembles the head of the mature worm, with a neck ending in a sac or cyst in which the neck and head are inverted. This is soon surrounded by a capsule of connective tissue. Such bodies, round or oval, and varying in size in different cases, are known commonly as "measles."

In some species of tape-worm compound scolices occur, forming groups of cysts containing daughter cysts, each one with its scolex, the whole sometimes reaching a large size.

The time necessary for the development of cysticerci varies in different species from a few weeks to several months. With some exceptions the cysticerci do not become sexually mature in the place of their formation, but must enter the "secondary" host. This usually occurs after the measles have been eaten, though the cysticerci of certain fish sometimes get into the water and swim about for some time.

Fig. 14.



Half-grown and mature proglottides of tænia solium; natural size (after Leuckart).

After the cysticercus enters the intestine of the secondary host the head is everted from the cyst, the latter disappears, and the parasite fastens itself to the intestinal wall and begins the formation of the tape-worm proper. The neck grows, and so forms the proglottides. The time necessary for the development of the strobila varies somewhat. In tænia solium it is about three months. The daily growth of tænia

saginata has been estimated by Perroncito at 3 cm. in the first and 14 cm. in the second month, the period of maximum development. In bothriocephalus latus, with much shorter segments, the growth has been estimated as 8 cm. a day.

The duration of the life of a single tape-worm varies much. Some of those in lower animals live but a short time; some in man have been estimated as living as much as thirty-five years. I have seen a bothriocephalus removed from a German woman who had been in America fifteen years, so it is safe to assume the worm in that case was at least fifteen years old. The death of the scolex usually leads to the death of the proglottides. The latter then break down and putrefy, or occasionally become desiccated, forming the so-called mummified worm. But in some of the tape-worms of birds the anterior proglottides form organs of fixation and so prolong the life of the parasite.

Tape-worms occasionally show deviations from the normal form, or monstrosities. The most important of these, according to the useful résumé of Blanchard,[1] are as follows: Discoloration, gray or black, from mercury, iron, or bile-coloring matter. Anomalies of the head, such as spontaneous separation of the suckers or the complete absence of hooklets in armed tape-worms. Three-sided tape-worms, the cross sections of which have the Y shape. These grow from scolices with six suckers. Incomplete division of the proglottides. Intercalated proglottides, very common abnormalities. Segments without genital apertures; less frequently segments with several genital apertures. Fusion of segments, sometimes quite extensive. Perforation of segments from fatty degeneration or premature attempts at separation of proglottides. Branching of the strobila.

Of the large number of tape-worms known to zoologists, only two genera occur commonly in man, though not always exclusively in him. Some of these, as well as others, also occur in the cysticercus stage in man. (See Echinococcus.)

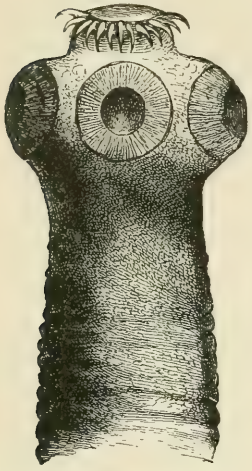
Tænia Solium.—(The word solium, as shown by Leuckart, appears not to be derived from *solus*, but from a Syrian word meaning "chain.") This is also sometimes called the "armed tape-worm," or the "pork tape-worm," from the fact that its cysticercus stage occurs in hogs as the *cysticercus cellulosæ*. From the time of Linnæus to within a recent period the common tape-worm of most countries has been called tænia solium, an error due to an imperfect diagnosis of the species which may frequently be seen at the present time. The fashion of calling this the solitary tape-worm is perhaps due to an erroneous derivation of the word solium. As a matter of fact, the pork tape-worm is said by many to occur in numbers more often than the beef tape-worm. Bérenger-Féraud has found fifteen, Küchenmeister thirty-three, and Kleefeld forty-one in one individual.

Tænia solium grows to a length of 2 to 3 m. or rarely longer. The spheroidal head is 0.6 to 1.0 mm. in diameter. On its summit is a short rostellum armed with a circle of twenty-two to thirty-two hooklets, of two sizes alternating. The hooklets are 0.11 to 0.14, and 0.16 to 0.18 mm. in length. The rostellum is often deeply pigmented. The suckers are hemispheroidal, 0.4 to 0.5 mm. in diameter. The neck is thin, from

[1] "Sur quelques Cestodes monstrueux," *Progrès médicale*, 1894.

5 to 10 mm. long. From it the proglottides gradually increases in size. At first wider than long, they become quadrate about a metre from the head, and from there gradually become longer than wide. Sexually mature segments measure 10 to 12 mm. in length, 5 to 6 mm. in width. The genital papillæ are on the edges of the proglottides, a little behind the middle, and alternate irregularly. The fully developed uterus consists of a median part, from which proceed seven to ten lateral branches, giving off secondary branches as they go out. The degenerated segments are usually narrower at the ends than in the middle.

Fig. 15.



Head of tænia solium (after Leuckart).

The eggs of the pork tape-worm are oval, the outer shell delicate, the shell of the embryo is thick, with radiating striations, yellowish, spheroidal, 0.031 to 0.036 mm. in diameter. The oncosphere is spheroidal, has six hooklets, and is about 0.020 mm. in diameter.

Monstrous specimens are not very common. Occasionally fusion of two or more proglottides is observed, or segments with holes in them. Rare monstrosities are those with six suckers or those with three-sided proglottides. Atrophic specimens are sometimes met with.

The mature pork tape-worm occurs only in the small intestine of man. The head is usually fastened in the anterior part, the mass of the worm lying in folds behind it. Küchenmeister found the head of the tape-worm in some cases between the folds of the mucous membrane, a position which must render difficult the access of vermifuges to that part. The tenacity with which the head is fastened to the intestinal wall was well shown in a case mentioned by Mosler and Peiper. In this a tænia in the intestine of a man examined three days post-mortem could only be loosened with difficulty. Put into warm water, the worm began lively motions. The end of the worm is occasionally found in the large intestine. A few loose segments are often to be found lying in the intestinal contents, and indicate the method by which loose proglottides are expelled with the stools. They sometimes wander out of the anus spontaneously. Under exceptional circumstances proglottides gain entrance to the peritoneal cavity, to the bladder, or to so called verminous abscesses in the abdominal wall. Occasionally the proglottides have been vomited.

The larval stage of tænia solium, the cysticercus cellulosæ, occurs in the intermuscular tissues or other organs of the domestic hog, but has been found also in some other animals, as the wild hog, cat, rat, ape, and in man. It is an elliptical cyst from 6 to 20 mm. long, and 5 to 10 mm. wide, in which the inverted head can be seen with the naked eye as a whitish spot. Feeding experiments showing the relation of the larval to the mature stage, and *vice versâ*, have frequently been made. The development of cysticercus cellulosæ requires from two and a half to four months. After some time it undergoes calcification of the cyst

walls. In water the cysticerci die at a temperature of about 120° F. In meat at ordinary temperatures they have been known to live twenty-nine days. The ordinary methods of smoking and salting meats do not kill cysticerci.

From what has been said it is evident that tænia solium is usually acquired by the eating of measly pork which has not been so treated as to kill the embryos. The hog in turn acquires the measles from the eating of proglottides from the human host, an infection easily understood by remembering the eating habits of hogs. The extent to which hogs are measly varies much in different countries. Where inspection of meat is carried out systematically and the swine properly fed the proportion of infected animals is smaller, other things being equal.

Infection with cysticercus in man takes place not only by taking embryos into the stomach with food containing measles, but also with food contaminated in various ways, as by washing with infected water, or having eggs deposited from fæces, or by the use of infected water itself, or even by transportation of eggs from the anus to the mouth in an accidental way. Should ripe proglottides enter the stomach in vomiting, cysticercus infection may result.

Tænia saginata; Tænia mediocanellata; Beef tape-worm; Unarmed tape-worm.—This is by far the commonest tape-worm in the United States, the idea formerly prevailing as to the frequency of tænia solium having been shown to be erroneous. Tænia saginata reaches a greater length than tænia solium. Worms of from 4 to 10 m. in length are not uncommon. The enormous lengths reported depend usually on stretching the worm in measuring it or in measuring parts of several worms as one. Out of 1597 specimens, Bérenger-Féraud found only six more than 11 m. long. However, in one case he found three tæniæ having a total length of 154 m. and a combined weight of 922 grammes. In measuring tape-worms they should lie flat, never be held up.

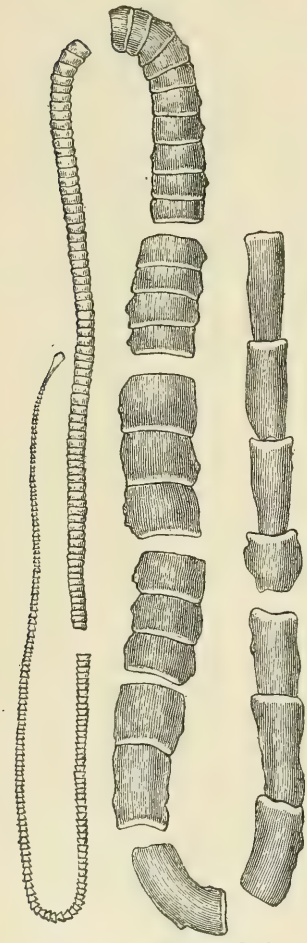
Tænia saginata has a cubical head 1.5 to 2 mm. in diameter. The four roundish suckers, 0.8 mm. in diameter, are usually pigmented. In the place of the rostellum there is a depression, also frequently pigmented. The neck is long and narrow; the proglottides gradually increase in size. The ripe ones are oblong, 16 to 20 mm. long, 4 to 7 mm. wide. The genital papillæ open just behind the middle on the edges, and alternate irregularly. The uterus has a narrow median trunk and twenty to thirty or more lateral dividing branches. The eggs are spherical; the shell has two or three filaments; the shell of the embryo is oval, thick, with radial striations, transparent and measuring 0.03 to 0.04 mm. long and 0.02 to 0.03 mm. broad. Tænia saginata is usually pale yellow, thick and fat-looking (hence the name, from *saginare*, to fatten), but sometimes it is thin. It may be stained by drugs, as already mentioned. Monstrosities occur sometimes, fusion of segments being not uncommon.

Tænia saginata occurs in its mature stage only in the human intestine. The ripe segments become detached and are expelled with the fæces. More frequently than is the case with the preceding species such segments have a tendency to wander out of the anus, when they travel around in the underclothes, occasionally continuing the migration

for some time. This worm is usually solitary (in 87 per cent. of cases, according to Bérenger-Féraud).

The cysticercus of tænia saginata occurs almost exclusively in cattle. It is small, up to 9 mm. long, and 5.5 mm. wide, and easily overlooked in the tissue of the beef in which it is sparingly distributed. From a half to one year is necessary for its development. The relation of the cysticercus bovis to tænia saginata has frequently been demonstrated experimentally. The experimental proof that tænia saginata is derived from cysticercus bovis was produced by Oliver in 1869 and Perroncito in 1877, but clinical observations on persons fed with raw or rare beef, or the special predisposition of certain races, as the Abyssinians, were sufficiently convincing. The prevalence of the disease in Abyssinia no doubt depends on the custom there of whole communities defecating on the meadows on which the cattle graze, and the use of raw or rare meat. The fact that the beef cysticercus is so rarely found depends partly on the fact that only a few cysts are present usually, and these are easily overlooked in the great mass of the host. Hertwig showed in the Berlin abattoir that the cysticerci are found most frequently in the internal pterygoid muscles. They also occur in the heart and lungs, and where these parts are examined the proportion of infected beeves recognized is much larger than otherwise, though varying much in different localities. Occasionally, as Mosler demonstrated experimentally, the cysticerci grow in enormous numbers in cattle, producing the so-called cestodian tuberculosis.

Fig. 16.



Tænia saginata; natural size (after Leuckart).

The geographical distribution of tænia saginata is worldwide. Not only is it the commonest worm in the United States, but in some parts of the Southern United States and in Mexico it is extraordinarily frequent. So Herff found in Texas that in some localities nearly every family was affected. My own experience in that State leads me to think that this estimate is not too high.

The occurrence of cysticercus bovis in the brain and eye of man has been claimed in a few cases.

The other species of tænia found in man are rare and need be only briefly described.

Tænia cucumerina, a common parasite of dogs and cats, has occasionally been found in human beings, usually in children, explained by

the greater exposure of these to infection from pet animals. The cysticercoid of this tape-worm lives in the dog louse (trichodectes canis), as shown by Leuckart and Melnikoff, according to Grassi and Rovelli in the dog flea (pulex serraticeps), and also in the human flea (pulex irritans). It does not occur, however, in the larvæ of the flea.

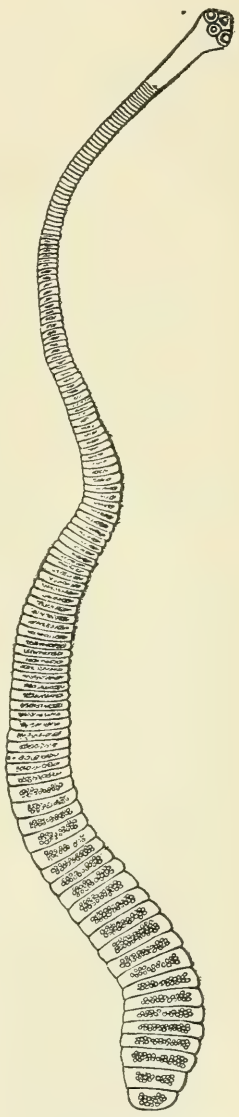
This is a small worm, from 15 to 35 cm. in length. The head is small. It has a club-shaped rostellum with three or four rows of thornlike spines. The suckers are large. The neck is short; the ripe proglottides are elliptical or the shape of a cucumber-seed, whence the name; reddish, 6 to 10 mm. long, 2 to 3 mm. wide. There is a genital pore on each side of a proglottis. The eggs are spherical, 0.043 to 0.050 mm. in diameter, few in number.

Fig. 17.

Tænia cucumerina; natural size (after Leuckart).

The ripe segments frequently wander out of the anus, and in the case of the dog can sometimes be seen crawling over the backs of their hosts. Then the eggs are swallowed by parasitic insects and enter the larval stage, so making infection in those who handle the animals an easy matter. In lower animals the worms often occur in numbers, and in children as many as forty-eight specimens have been observed in one case.

Fig. 18.



Tænia nana; × 12 (after Leuckart).

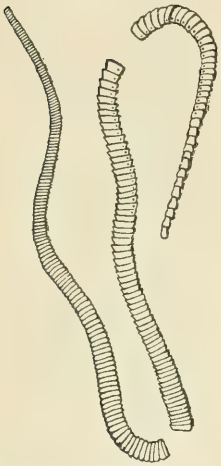
Tænia nana (von Siebold, 1852); Hymenolepis nana (Blanchard, 1891).—The dwarf tape-worm grows to a length of 20 mm., or in rare cases 27 mm. It is 0.5 to 0.7 mm. wide. The globular head is 0.25 to 0.3 mm. in diameter. The rostellum bears a single circle of twenty-four to thirty small hooklets. The four suckers are round. The neck is rather long, the 150 to 200 proglottides short, the posterior ones yellow; the genital orifices are all on the same side. The oval eggs have three structureless transparent shells, and are 0.030 to 0.050 mm. in diameter.

First discovered by Bilharz in 1859, this worm was long considered rare, but within the last ten years many cases have been described, especially in Italy. Tænia nana has been found especially in children, in whom it sometimes occurs in enormous numbers (250 in one case, more than 370 in a case reported by Mertens, more than 2000 at one time in a case observed by Lutz). The develop-

ment of tænia nana is not definitely known. According to Leuckart, the larval stage is passed in an insect. The large numbers found together lend support to the idea that this species does not require an intermediate host, but develops from the egg through the cysticercoid stage in one and the same host.

Tænia flavopunctata (Weinland, 1858), or, more properly, tænia diminuta (Rudolphi, 1819) is a small tape-worm, sometimes reaching a length of 60 cm. and a width of 3.5 mm. The head is small, club-shaped, with a rudimentary unarmed rostellum and round suckers. The genital pores are all on one side. This worm has been found a few times, especially in children. It was first described as a human parasite by Weinland, the specimen having been obtained from a child nineteen months old in Boston. Later, Leidy reported the same species in Philadelphia, and since then it has been found in various parts of Europe and in Brazil. The same parasite is common in mice and rats. The larvæ live in butterflies and their larvæ and in other insects. Rudolphi gave the name tænia diminuta to the parasite of the rat in 1819. Some specimens derived from man have been preserved in the museum of the veterinary school at Alfort since the end of the last century, though only recently recognized by Railliet and Zschokke.

Fig. 19.



Tænia flavopunctata; natural size (after Weinland.)

Tænia Madagascariensis is a worm found in only a few cases in persons who were infected in various parts of the East. It is an armed worm, reaching a length of 30 cm. The larval stage is not known, but the larva is supposed to live in birds.

Bothriocephalus latus; Tænia lata; Broad tape-worm.—This is the largest tape-worm infesting man, and from its history and pathological relations is extremely important. The head is 2 to 3 mm. long, clavate, with two deep longitudinal, groovelike suckers, one on each side. The neck is thin. The proglottides eventually become wide from side to side, but are short from before backward, the largest measuring 10 to 18 mm. by 5 to 6 mm., and have been found to number as many as 4200 in one individual. The uterus forms a rosette-shaped mass in the centre of the proglottis; the cirrus and vagina open just behind the uterus. The eggs are elliptical, brown, granular, with a lid, and measure 0.068 to 0.071 mm. long, 0.045 mm. wide. The proglottides are usually grayish yellow on the edges, bluish gray in the middle, the rosette yellowish, giving the worm a striking appearance.

The geographical distribution of bothriocephalus is peculiar. In Europe it occurs especially in French Switzerland and the German Baltic provinces of Russia, and from both of these chief foci it appears to have spread out into the neighboring countries, so that Lombardy, Germany (Bavaria), Finland, and Sweden are especially affected. It also occurs in North Germany and in Holland, and its existence in Roumania has been demonstrated by Babes. In Japan the broad tape-

worm is the commonest cestode of man and dogs. In the vicinity of the Lake of Geneva the inhabitants are infected to the extent of 20 per cent. In Dorpat, Cruse found 6 per cent. of bodies infected; in Moscow eggs were found in 8.9 per cent. of persons examined. The distribution of the worm varies, however, so that in some countries, especially in Germany, where it was formerly rare, it is now becoming common; on the other hand, it was common in Paris in the last century, but is now seen there only in imported cases.

The development of bothriocephalus was worked out by M. Braun. The scolices or plerocercoids are 8 to 30 mm. long, with heads that are inverted at rest, but can be made to evert by warming them. These occur especially in the muscles and intestines of the pike, carp, salmon, and many other fish. They are not killed by slight smoking, salting, or freezing. Braun was able to infect not only cats and dogs by feeding them with larvæ from fish, but also three students in Dorpat. Within a month the worms developed, and on removal were found to have reached a length of from 310 to 450 cm., with ten hundred to thirteen hundred proglottides. Similar experiments have since been made by others, which not only confirm the mode of infection, but also the great rapidity of growth of the parasite. The mode of infection of the fish, however, is not known. There may be an intermediate host. It is possible also that the embryos of the bothriocephalus may be ingested in other ways than by eating fish. Zaeslin claims that in Switzerland infection takes place through eating lettuce. This is sometimes raised under irrigation from lake-water, which may carry eggs or measles to the plants. This would explain the cases of persons who do not eat fish, and yet have been infected with bothriocephalus.

In the United States of America bothriocephalus has frequently been observed, but, so far as I can learn, only in immigrants. Three hitherto unreported cases known to the writer—two in Galveston, Texas, one in Leadville, Colorado—were in such people. Herff, however, believes that the parasite is indigenous in Mexico. Bothriocephalus occasionally occurs along with other tape-worms. It also occurs sometimes in large numbers; Böttcher found 48 young ones in the intestine of a woman, the intestine having been partly washed before the worms were discovered.

Bothriocephalus cordatus, a parasite of dogs, walrus, and seals in Iceland and Greenland, has been found occasionally in man.

Bothriocephalus cristatus and *bothriocephalus Mansoni* have also been occasionally found in man.

Etiology.—The cause of tape-worm disease in man has been almost completely elucidated by researches in the development of these worms briefly described in the foregoing pages. As a rule, infection takes place by the ingestion of meat improperly cooked. The danger of infection is of course greater in a country where meat (including fish) is frequently infected. Accidentally, tape-worms may be acquired by handling infected meat, or in some species by handling pet animals infested by parasites containing larvæ of the worms.

Tape-worm is most frequent in early middle life, but cases are not infrequently seen in the extremes of life. Mensinga found a tænia solium in a child ten weeks old. The infant had been infected by contaminated milk when two weeks old.

The disposition of the two sexes is differently stated by authors, depending no doubt on peculiarity of clinical material.

Symptoms.—The symptoms produced by the presence of a tape-worm in the intestine vary so widely that while some attribute to these parasites an endless array of diseases, others deny them any influence on the host. As usual, the truth lies between these extreme views. Subjective and objective evidences of tape-worm may be entirely absent, and in the experience of the writer usually are with common tape-worm in persons of good constitution, and especially those who eat a great deal. In one case a perfectly healthy man after eating a quantity of raspberry preserve was obliged to defecate in a meadow. He was struck by the peculiar appearance of the stool, which contained, according to his description, almost a half pint of tape-worm. Remembering the tradition that raspberry preserve is a remedy for tape-worm, he suspected he had one and consulted me. A course of treatment instituted at once brought away one large beef tape-worm, so that the patient must have been the host for at least a number of months without any symptoms whatever. Another patient, like the first a *bon vivant*, consulted me about some curious bodies which from time to time got into his underclothes, and which proved on examination to be sterile proglottides of a very large tænia saginata.

In other cases patients complain of an array of symptoms truly formidable. In this connection "helminthophobia" may be mentioned. This is met with frequently in neurasthenic persons, also in men, especially men who give no other evidences of neurasthenia, but who either from reading or conversation have learned some of the symptoms of tape-worm, and imagine they are so afflicted.

Among the symptoms observed in actual cases disturbances of digestion are common. The appetite may be voracious, as is believed by the laity, but is sometimes poor, at other times capricious. Vomiting, nausea, and eructations sometimes occur, and, especially in case the worm is the pork tape-worm, may have dangerous consequences by reason of the proglottides getting into the stomach.

In some cases colicky pain or pain of a heavy, boring, cutting, or tearing character may be felt. These sensations sometimes follow the eating of sour or bitter articles of food, or when such things as raspberries or strawberries have been eaten, and may be easily explained by an irritation of the parasite and consequent increased activity, or perhaps on account of unusually active efforts on the part of the worm to maintain its hold on the intestinal wall. On the other hand, bland substances, and especially milk, often cause cessation of such symptoms. There may be constipation or diarrhœa or these may alternate.

Nervous disturbances sometimes occur in tape-worm disease, especially in children. They seem to be more likely to occur in the case of infection with tænia cucumerina, nana, and flavopunctata, which so especially affect children. Convulsions, chorea, psychic disorders, epilepsy, aphonia, asthma, palpitation of the heart, fainting, and dizziness may also occur with other species of tape-worm, but would appear to be relatively more frequent with the rarer species.

Either with or without other symptoms, but especially when these are present, patients are prone to become pale and to feel weak and

irritable. Part of the cachexia sometimes present may be due to loss of nutritive material consumed by the parasite.

During the last ten years a large amount of evidence has accumulated tending to show that bothriocephalus may cause a severe anæmia. The matter has been ably and apparently conclusively settled by the admirable work of Schaumann of Helsingfors.[1] This author shows that the anæmia accompanying the parasites named has all the clinical and anatomical features of pernicious anæmia, including all the changes in the blood discovered by recent methods of investigation. The condition, however, is not so unfavorable as pernicious anæmia of other kinds. Concerning the pathology of the disease, Schaumann inclines to the view that there must be some other cause present besides the tape-worm, perhaps micro-organisms. A very curious fact is that in some cases eggs of the bothriocephalus have been found in the fæces, but treatment showed that either there were no worms present or there were dead ones in a state of decomposition—a fact which led Dehio to raise the hypothesis that the products of decomposition of the dead worms are accountable for the anæmia. Schaumann thinks the blood corpuscles are destroyed by pathogenic substances, and the blood-forming organs affected secondarily.

Tape-worm disease is sometimes accompanied by rise of temperature. This has also been attributed to the fact that the tape-worm or segments of it have died spontaneously or as the result of treatment, but have not been removed from the intestine.

Of all the symptoms, the passing of the segment is the most certain, provided, of course, that the diagnosis of the segments is correct. Segments may be found with the stools or the proglottides may wander out by themselves. I have mentioned one example of this. Mosler and Peiper mention the case of a student in Giessen whose bed used to be filled with proglottides which had escaped in the way described, and another case in which the segments escaped in the same way from a lady while dancing at a ball. A worm may be present for a long time before migration begins.

The entrance of proglottides into the stomach in vomiting is extremely rare. Von Siebert has reported a case in which the worm lay in a reversed position, so to speak, with the head down, and it has been supposed that this would assist in the passage of the proglottides in reverse peristalsis, yet this is by no means necessary, as the worm sometimes lies in a compact skein, in which the end is not more than a foot away from the head, sometimes even at the same level. In a remarkable case cited by Leuckart a farmer vomited a worm into his mouth. As the physician was carefully extracting the parasite the patient bit the latter through, thinking his bowels were being removed! Frankenhausen has reported the case of a patient who had vomited proglottides and later acquired cysticerci.

Diagnosis.—The diagnosis of tape-worm can only be made by finding the segments or eggs in the stools or after being otherwise evacuated. Any other method of making a diagnosis involves so many sources of error that it can only be used by charlatans.

If suspicion of the existence of worms is aroused by any of the nu-

[1] *Zur Kentniss der sogenannten Bothriocephalus-anämie*, 1894.

merous symptoms or by a history of exposure, as by eating raw meat, etc., a purgative should be given and the stool examined. The stools may be examined without this, and in many cases the eggs may give the required information. But as the discovery of proglottides is so much easier, and as the purgative may with advantage be followed up by the proper treatment, it is on the whole preferable. Moreover, the examination of the proglottides gives more certain information as to the species, especially as between tænia solium and tænia saginata; and this knowledge is often of value in treatment, the latter being usually more difficult to remove than the former. Prognosis as to removal is usually good, especially if the patients can be relied upon to carry out the unpleasant treatment. In the case of tænia solium the danger of cysticercus should be borne in mind in the prognosis, and in bothriocephalus latus the possibility of severe or fatal anæmia. The latter can almost certainly be prevented by timely treatment.

Prophylaxis.—The prophylaxis of the various forms of tape-worm appears from a consideration of their natural history. Inspection of meat, care in the feeding of animals to be used as food, and disposal of excreta of infected persons are as easy to point out as necessary as they are difficult to enforce in practice. In the larger abattoirs we believe it is no longer customary to feed animals with the offal of those recently killed, nor to let hogs feed on human and other excrement. In smaller towns and in the country there is still much to be done in that respect. The bothriocephalus appears not to have settled yet in this country. With the increase of infected persons from Europe, however, our fish may become infected, and so cause the increase of that parasite here, as has happened in various parts of Europe. The importance for all persons who have tape-worm of avoiding contact of the mouth with infected hands is evident. In addition to the precautions mentioned the thorough cooking of meat is important.

Treatment.—All methods of treating tape-worm which offer much chance of successful removal are unpleasant and even severe. They should, therefore, not be used unless a worm is known to be present. In the old, in children, in weak and cachectic persons treatment should be carried out only when there are symptoms which make the removal urgent, even if at some risk.

The advantages of treating patients with tape-worm in a hospital are evident. The preparation of the patient and the removal of the parasite are much easier there than in a private dwelling, especially if the physician is for any reason prevented from being present at the critical time.

The most important thing in the treatment is to have the intestines as empty as possible. This is done partly by a thorough use of purgatives and enemata. Not only does this render more certain the contact of the remedy with the worm, but it also makes the search for the head much easier. Having had the patient avoid large meals for several days, and having been certain that large stools have been passed in this time, the patient on the day before the actual treatment eats nothing after midday, unless such things as are known to have little nourishment for the worm. Strong coffee, herring salad, salt mackerel, pickles, cabbage, or raspberry jam are permissible. Wine or wine and water

may be taken. In the afternoon a brisk purgative should be given. Calomel is the best thing to use for this purpose, and sometimes brings away the whole worm, so that all the stools passed after it is taken must be kept and examined. Next morning the treatment proper is given. The patient should remain in bed. Nothing should be taken before the medicine, unless, if the patient is weak, a cup of black coffee. If there is nausea, ice or champagne should be used. If the remedy is vomited, it should be given again—if necessary through a stomach-tube. If the treatment is effective, the worm will usually pass in one or two hours. If the head does not pass in an hour, another purgative should be given, this time a bottle of citrate of magnesia, a Seidlitz powder, or a full dose of Hunyadi water. If there is no stool within two hours, a large enema should be given.

In order to manage the expulsion the physician or a nurse experienced in such matters should be present all the time. If fragments of worm are passed, they must be examined to see if the head, or, if fragments of more than one are present, the heads, have passed. The head may come down part way, but take hold again low down, or the worm may remain loose in the bowel without being expelled. Sometimes the worm is partly expelled. If the head is not benumbed by the treatment in such case, it takes hold again, the worm is retracted with great force, and either breaks or is entirely withdrawn again. In all these cases high enemata of water or soapsuds should be given promptly, and will often be successful in causing the expulsion of the worm.

The search for the head or heads must be made by washing the dejection carefully and examining all suspicious particles. Pieces of worm should be carefully spread out on glass plates in the proper order of the segments. Everything used in the examination must be carefully cleaned afterward, the worm burned or properly preserved, hands carefully washed and disinfected. Directions as regards these points cannot be too plainly worded. In the case of an intelligent man to whom I had fully explained the matter, and warned not to touch any of the dejections before my arrival, I found that curiosity had overcome prudence, and my patient was busily engaged in picking over fragments of the neck of a tænia saginata in a kitchen sieve with the handle of his tooth-brush. The head was of course lost, though subsequent events proved it had come away.

Of remedies for tape-worm, the best is beyond doubt the ethereal extract or oleoresin of male fern, oleoresina aspidii of the United States Pharmacopœia. This can be given in gelatin capsules or mixed with sugar in the dose of from one to two and a half drachms to adults. Male-fern extract varies greatly in its efficacy, depending partly on the time of gathering, partly on the place of growth, and partly on the mode of preparation. In some cases it seems better to give the male fern with other remedies. A useful combination is—

℞. Oleoresinæ aspidii, ʒij;
Chloroformi, ʒij;
Olei tiglii, gtt. iv;
Glycerini, ʒij—M.
Sig. Take half at 8 A. M.; the rest in one hour if necessary.

Such doses of male-fern are rarely dangerous. For a while the drug was given in larger doses, and a number of cases of intoxication were reported. For the most part the doses were from fifteen to forty grammes. The toxic symptoms are dyspnœa, nausea, vomiting, colicky pain, diarrhœa, followed by albuminuria, jaundice, tremor, amaurosis or amblyopia with dilated and fixed pupils. Death occurs with tetanic convulsions. From investigations made by Poulsson it appears that the toxic principle is the same as the anthelmintic substance. This occurs in two forms—an amorphous and active, and a crystalline indifferent substance. The latter is the anhydride of the former. To the two substances Poulsson gives the names filicic acid and filicin, terms formerly incorrectly applied. In preparations containing both substances the active form may be changed into the other, so altering the efficacy of the preparation. Poulsson also found that the absorption of filicic acid is increased by oils, and recommends that the use of castor oil be given up in connection with male fern. The dose of filicic acid is from 0.9 to 1.2 grammes.

As substitutes for male fern one of the following may be used:

Pomegranate.—The fresh pomegranate root (rind) may be taken as a powder or better as a decoction, made by macerating two ounces of powdered bark in half a pint of water for twelve hours and boiling to half a pint, the whole to be taken at once. This causes as a rule more nausea than male-fern, and frequently causes vomiting. For that reason it is given sometimes by the stomach tube. As a substitute pelletierin tannate may be used. The dose of this is variously given as from one to twenty grains. It is often given in five grain doses, but is not reliable and sometimes causes toxic symptoms.

Kousso, said to be very prompt in removing worms when the dried flowers are fresh, is less effective as found in the shops. It may, however, be used in combination with other remedies, and forms a useful but unpalatable vehicle for male-fern extract in doses of one to two ounces.

Turpentine is highly praised by many. It is given in widely varying doses, from a few drops up to two ounces. I have known it to fail in the latter dose, though causing severe strangury.

Pumpkin seeds have the advantage of making a not unpleasant mass, and can therefore be used in children when other remedies cannot be swallowed. The dose is from 60 to 120 seeds, broken up, and the cotyledons mixed with sugar.

The treatment of tape-worm usually causes great intestinal irritation, indicated by the passage of considerable amounts of mucus. The stomach also is often affected. The patient should therefore take but little to eat soon after treatment. Usually it is better to begin with milk and lime-water or Vichy water. Cracked ice and bismuth are often useful.

If the head is not found, no other attempt at removal should be made until segments appear again, usually not earlier than two months after treatment.

Nematodes.

Nematodes are usually slender, cylindrical or spindle-shaped worms, and from their shape commonly spoken of as round-, thread-, or pin-worms.

The surface is cuticular, often corrugated, and sometimes has spines, bristles, hooks, or papillæ. The mouth is at the anterior end, which is usually tapering. At the round or pointed posterior end is the anus. There is a straight alimentary canal, extending from mouth to anus. The sexes are usually distinct; the male is smaller and more slender than the female, the posterior end slightly curled. The male sexual apparatus consists of testicles of simple structure, emptying by a seminal vesicle and an ejaculatory duct into a cloaca. In the dilated bursa lies a chitinous spicule which serves as a copulatory organ. The female organs of generation consist of two sets of tubules, each of which dilates into a uterus. These latter unite and form the vagina, which opens on the ventral surface some distance in front of the anus. Beneath the cuticle is the cellular layer from which the cuticle is formed. The muscular system consists of a single layer of longitudinal fibres. The nervous system consists of a series of ganglionic masses and circular fibres surrounding the œsophagus, with longitudinal fibres passing forward and backward from them. There are sense organs in some forms in the mouth, but special sense organs are absent in the parasitic forms, though there are eye-spots in some others. There is a simple system of excretory canals which open near the anterior end of the body.

Not all nematodes are parasitic. Some are free in all stages, living in water, salt or fresh, or in damp earth. A familiar form is the vinegar eel (anguillula); others are parasitic in plants, in some cases causing serious loss to crops; others, especially trichina and the forms we have now to consider, are parasites of man.

The impregnation of the eggs of nematodes takes place in the uterus. Some of the species are oviparous, others viviparous. In some species change of host is necessary for development, and in some of these heterogeny occurs, the alternate generations being parasitic.

Strongyloides intestinalis; Anguillula intestinalis et stercoralis (Bavay); Rhabdonema strongyloides (Leuckart).—This is a round-worm discovered by Normand in the fæces of French soldiers with so-called Cochin-China diarrhœa. Supposed at first to be two species, Leuckart showed that the worms represented two generations, one of which lives in the intestine, while the other becomes sexually mature outside of the body, and its young in turn live as parasites.

The parasitic generation appears as a round-worm 2.2 mm. long, 0.034 mm. wide. The cuticula is finely striated. Around the mouth are three deep lips. The males are smaller than the females. The eggs are 0.050 to 0.058 mm. long, 0.030 to 0.034 mm. wide.

The non-parasitic generation has smooth bodies, cylindrical, but tapering toward the anterior end, pointed at the other end. The three lips are less distinct. The males are 0.7 mm. long, 0.035 mm. wide; the posterior end is rolled up; there are two small curved spicules. The females are about 1 mm. long, 0.05 mm. wide; the tail end is straight and pointed. The vulva is behind the middle of the ventral surface. The eggs are 0.070 mm. long, 0.045 mm. wide.

The parasitic generation lives in the intestine (and sometimes in the bile and pancreatic ducts), where the young ones are developed. These are expelled with the fæces, in which they are at first from 0.45 to 6 mm. long. The females of this generation lay from thirty to forty eggs each,

which rapidly develop, but unless they soon enter the intestine they die. Infection takes place either by drinking water containing larvæ, or perhaps more frequently by the use of contaminated vegetables. Supposed at first to be peculiar to Cochin-China, this parasite has since been found in other parts of Asia, in the Malayan and Sandwich Islands, Martinique, Brazil, and Italy. In the latter country it was found in St. Gothard tunnel workmen, along with anchylostoma. Allied species are parasitic in hogs, sheep, rabbits, and other animals. Though no longer looked on as the cause of the diarrhœa with which these parasites are associated, they grow in enormous numbers when from various causes the resistance of the body is diminished. In such cases it has been estimated that as many as a million worms a day have been passed by one patient. It is said the natives in the East are immune, which is ascribed by some to the use of the betel nut.

The worms are most readily expelled by the administration of male-fern.

Trichocephalus dispar; Long thread-worm; Whip-worm; Hair-worm.—This worm grows to a length of 45 to 50 mm. and a width of 1 mm., the female being a little longer than the male. The body is

FIG. 20.

Eggs of trichocephalus dispar; × 275 (Eichhorst).

FIG. 21.

Trichocephalus dispar, male and female; natural size (Eichhorst).

yellowish white and cylindrical, the anterior half to three fifths being of hairlike thinness. The tail end of the male is rolled up; the spicule, 2 to 2.5 mm. in length, lies in a bursa set with hooklets. The eggs are lemon-shaped, with thick brown shells, projecting and clearer at the ends.

This is one of the commonest parasites of man, though seldom noticed, as it usually gives rise to no symptoms and is easily overlooked. It occurs in all parts of the world. In autopsies it has been found to the extent of 50 per cent. in Paris, 89 per cent. in Dublin, and almost constantly in some parts of Italy. It lives in the cæcum, appendix vermiformis, and colon, and sometimes in the small intestine. At post-mortem examinations the whiplike end of the worm is often found imbedded in the mucous membrane. The parasite also occurs in certain apes and lemurs.

The development of the whip-worm takes place in water. The eggs are extremely resistant to heat, cold, and drying. The dried eggs are blown about by the wind and enter the intestine either with food or water. The observations of Grassi have demonstrated that an alternation of hosts is not necessary.

Usually the worms are present in small numbers, not more than twenty. However, larger numbers sometimes occur, and Rudolphi once counted more than a thousand in a cadaver. They occur at all ages and in both sexes.

Symptoms.—Usually when only a few worms are present there are no symptoms. When large numbers are present there may be evidences of local irritation, such as diarrhœa, vomiting, emaciation, and loss of strength. In some cases there have been nervous symptoms, even simulating meningitis. Occasionally there is extreme anæmia. There may be excessive diarrhœa, with twenty to thirty bloody and mucous stools a day. In such cases the existence of a severe enteritis cannot be doubted, and some authors claim that the parasites cause ulceration.

Diagnosis.—The diagnosis can only be made by an examination of the stools for the eggs or the worms themselves. The eggs are usually present in very large numbers. In some cases the parasites have been seen on the prolapsed rectal mucous membrane. The prognosis is not unfavorable, notwithstanding the difficulty of removal.

Prophylaxis.—As in the case of other parasitic worms, the most important thing in prophylaxis is cleanliness as regards eating and drinking. Children must be taught to avoid eating dirt. The prophylaxis is especially important in asylums.

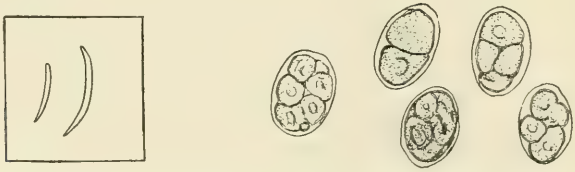
Treatment.—Owing to the location of the parasites, their removal is attended with considerable difficulty. Male-fern is sometimes effective, especially when combined with large enemata. Enemata containing benzine have been recommended, as also thymol (see Anchylostoma). Tonics are usually useful.

Anchylostoma duodenale (Dubini, 1843); Strongylus quadridentatus (v. Siebold, 1853); Dochmius anchylostomum (Molin, 1860); Dochmius duodenalis (Leuckart, 1876), etc.—This, the most important of the round-worms, is a reddish cylindrical parasite, tapering at the anterior and curving at the posterior end. The mouth is capacious, and contains teeth, four of them in front on the ventral surface, pointing backward, and two on the dorsal surface, pointing forward. Farther back is another dorsal tooth, pointing forward, and a pair of flat chitinous lamellæ. The males are from 8 to 10 mm. long; their posterior extremity ends in a small spine. The vulva is in the posterior third of the body. The eggs are elliptical, with thin shells, 0.052 mm. long, 0.03 mm. wide. As found in fresh fæces they show segmentation in various stages.

Anchylostoma was found by Dubini in Milan in 1838, reported in 1843, but became important only when Griesinger (1854) showed that it was the cause of the so called "Egyptian chlorosis." Other names given to the disease produced by the worm are "mal cœur" (Antilles), tun-tun (Colombia); opilação (Brazil); tropical anæmia or hypohæmia, mal d'estomac, allotriophagia, cachexia Africana s. Americana, etc. These conditions have been observed in various parts of the world since the last century, but their real nature has only been recognized since the discovery of Griesinger. Bilharz, who confirmed Griesinger's observations in Egypt, found the parasites in almost all his autopsies. Since then anchylostoma has been found in Brazil, Guiana, Senegambia, Japan, the East Indies, Hawaii, and especially in Italy. In the latter

country the anæmia of workmen in brickyards, long known as an endemic disease, was proved by Grassi and Parona to be due to anchylostoma. The worms soon after became more celebrated on account of their connection with the anæmia of the engineers and workmen in the St. Gothard tunnel, as shown by Perroncito, Concato, and Bozzolo. These observations led to an investigation of the so-called miner's anæmia, attributed formerly to lack of light and bad air, and in this, too, in France, Italy, and Hungary the relation of the anchylostoma was demonstrated. In Germany anchylostoma has frequently been found, especially in workmen in brickyards in Bonn, Cologne, and other places. In Belgium also there are foci of disease. As the parasites have been carried to various parts of Europe by travelling workmen, new foci are discovered from time to time. In the United States anchylostoma does not appear to occur naturally. The statements in modern works, especially in those of European origin, that this parasite occurs in the Southern States, seems to have arisen from confusing the ordinary dirt-eating of the Southern negroes with various forms of anæmia, some of which are now known to be caused by anchylostoma, observed in the tropics. From the excellent description of Duncan,[1] the resemblance of the clinical appearance is quite complete. The disease, however, differed in a striking way from anchylostomiasis in that it did not become endemic. Duncan says that "almost every large plantation has three or four of them [dirt-eaters], and sometimes more." When we consider that the habits of these slaves were about the same as those of persons of the same class in Brazil or Egypt, this fact seems of considerable importance. Duncan thought dirt-eating was due to gastric disorders "produced by a deficiency of suitable nourishment." His testimony to the efficacy of tonic treatment with proper food and fresh air also seems opposed to the idea of a parasitic cause. Sir Charles Lyell also, in his remarks on dirt-eating in Alabama, says not a word about parasites, and the marked characteristic of anchylostomiasis, its tendency to become endemic, is not mentioned by that acute observer. The first case reported in the United States was communicated by the late Dr. W. L. Blickhahn of St. Louis.[2] The patient was a brick-

FIG. 22.



Anchylostoma duodenale with eggs (after Blickhahn).

maker from Oberhausen near Essen, who had been in America seventeen months at the time he came under Dr. Blickhahn's observation. Dr. F. G. Möhlan[3] has reported some interesting cases from Buffalo, N. Y. Some of the patients seem to have acquired the disease in that city, perhaps from Italian or Polish laborers. Through the courtesy of Dr. Joseph Collins I am able to mention another case, a patient of Dr.

[1] *Fenner's Southern Medical Reports*, vol. i., 1849, p. 194.
[2] *Medical News*, Dec. 9, 1893.
[3] *Buffalo Medical Journal*, March, 1897.

Joseph Fränkel. The patient was a foreigner who had long lived in the United States, and who seemed to have acquired his disease here, perhaps from handling hides. As the conditions in many parts of the country, especially in the Southern States, are favorable for the development of the parasite, it will be strange if among the large number of Germans and Italians who come to this country the disease does not become permanently established. Herff thinks the parasite occurs in Mexico.

DEVELOPMENT.—The eggs are passed in the fæces in the early stages of segmentation. Further development is prevented by the lack of oxygen in the intestine, the need of which on the part of the eggs has been shown by Leichtenstern. The number of eggs passed is enormous. Leichtenstern estimated that in an evacuation weighing half a pound there were four million. The number of eggs passed has a relation to the number of female worms. For the development of these eggs it is necessary that they be exposed to a moderately warm temperature, between 77° and 86° F., be not too densely aggregated, and be exposed to the air. They flourish best in thin fecal matter. In watery or in hard fæces they soon perish. Freezing, exposure to the direct rays of the sun, or even a temperature of 113° F., also kills them. The addition of clay or garden earth to fæces is also injurious to the development of the embryos, though Wucherer cultivated them in moist earth, and Seifert did the same in clay.

In cultures the embryos are developed in from two to four days, and then escape from the eggs. After their exit the embryos grow rapidly and become encysted, a process formerly looked on as due to the formation of a chitinous skin. They undergo, also, certain changes in the relative sizes of the various parts of the alimentary canal. The cyst protects the embryos against external influences, and may be renewed. In this stage the embryos may be transported by water or even by wind. In water the encysted parasites can remain alive for a long time, as much as seven months, according to Leichtenstern. If the encysted embryos enter the human duodenum, the "skin" is digested and the parasites develop into the mature forms. Between infection and the earliest appearance of the eggs in the fæces a period of from five to six weeks elapses.

In man the worms are found in the duodenum, jejunum, or the upper part of the ileum, especially in the jejunum. The duodenum may have none at all, and the occurrence of parasites in the pylorus or stomach is looked on as being accidental.

Females always preponderate, in proportions varying from 6 : 1 to 3 : 2 of the males. This difference is thought to be due to the fact that the males frequently change their position for the purpose of procreation, and are so exposed to the risk of being carried off by the intestinal contents. The ecchymoses on the intestinal walls show that the younger worms change their position more frequently than old ones. The life of anchylostoma appears to be not longer, as a rule, than five, never more than eight, years. Cases of spontaneous recovery seem to indicate that when the worms reach a certain age they die or are swept out of the intestine in consequence of diarrhœa, and so permit spontaneous recovery.

Etiology.—The term anchylostomiasis has been given to the results of infection by the anchylostoma. It is a disease of those who work in soil. So brickyards, mines, and tunnels have furnished almost all the cases. Sporadic cases rarely occur. The frequency of the disease in Egypt has been mentioned. In the construction of the St. Gothard tunnel the cases aggregated thousands. Infection takes place in most cases by contamination of the food with infected earth. The earth becomes infected by carelessness in regard to defecation, especially in the neglect of sinks. The eggs adhere to the hands or get under the nails, and the workmen eating, as they often do, without washing their hands, and taking their food directly with their hands, convey the eggs in that manner. In Brazil, Lutz found the disease common among children—a fact which no doubt depends on the habits and customs of early life. Rathonyi has found anchylostoma in horses, without symptoms, in infected mines.[1]

Mosler and Peiper[2] thus sum up the local conditions which most effectually foster the spread of the disease:

Moist, flat, and impermeable soil, which assists in the stagnation of water; absence of sinks; excretion of fæces loaded with eggs in the vicinity of human dwellings or work-places.

Anchylostoma lives on the blood of its host. Live specimens examined soon after the death of the host show the intestine filled with blood. The red blood corpuscles are unchanged, so that the parasites seem to live principally on blood serum. The loss of blood to the subject when the parasites are numerous can be readily imagined. Thus Grassi found more than 3000 in one case. Of 28 cases examined by Leichtenstern, only 9 had less than 100 parasites; 14 had 100 to 500, 3 more than 500, 1 having 2763.

Pathological Anatomy.—The alterations found post-mortem in persons dying of anchylostomiasis are for the most part those of severe anæmia. The muscles are pale and soft. The adipose tissue is sometimes well preserved. Anasarca, ascites, hydro-thorax, hydro-pericardium, and effusion in the meninges are frequent. The heart is often dilated, sometimes dilated and hypertrophied, the muscle soft, brown, and fatty degenerated. The clots are small, soft, and brown. The liver, spleen, and kidneys are often atrophic.

The stomach has been found dilated in some cases, in others with chronic inflammatory changes in the mucous membrane. The characteristic changes are in the small intestine. In the upper part there is often a red or chocolate colored mass, or there is fluid or coagulated blood in varying quantities. In the lower part of the duodenum, the jejunum, and the upper ileum there are small ecchymoses in the swollen mucous membrane, especially marked between the folds. The ecchymoses are usually more numerous than the parasites. Microscopic examination shows in the middle of the hemorrhagic spot a hole, and around the latter infiltration of leucocytes. In long-standing cases the ecchymoses are followed by pigmentation of the mucosa.

If the examination is made with proper precautions and within a short time after death, the parasites will be found fastened by their

[1] *Deutsche med. Wochenschrift*, No. 41, 1896.
[2] *Nothnagel's Spec. Path. u. Therap.*, Bd. vi., 1894.

mouths to the mucosa, or sometimes deeply buried in the membrane, and so firmly attached that they can only be removed with difficulty. The males are more difficult to find than the females, and sometimes lie covered over with mucus in grooves they have formed in the soft mucous membrane. Sometimes the parasites bore through the mucosa, and lie in spaces which have been looked on by some as cysts, but which are really, as Griesinger thought, accidental.

Secondary changes in the abdomen, such as enlarged mesenteric glands and adhesions of the peritoneum, are sometimes found.

The bone-marrow shows changes like those of severe anæmia.

Anchylostoma is sometimes associated with other parasites, such as anguillula, ascaris, or oxyuris.

Symptoms.—The characteristic symptoms of anchylostomiasis are progressing anæmia, weakness, and cachexia. When the parasites are few the symptoms may be absent. Where they are numerous the symptoms begin about three or four weeks after infection.[1]

Local symptoms are occasionally observed, always when large numbers of young worms are present, and are due to the irritation of the intestine by the parasites. The commonest local symptom is pain or tenderness in the epigastrium or just below the liver. According to Lutz,[2] the pain is most marked to the right and left of the epigastrium, of a cutting, stabbing, burning, or constricting character. Sometimes it is diffuse. Other symptoms are pyrosis, colicky attacks, loss of appetite, or in some cases inordinate appetite, nausea, and vomiting. The vomitus is rarely bloody; it sometimes contains eggs of anchylostoma. The tongue is coated. The abdomen is sometimes tympanitic. Stomatitis has been noted in some cases. Salivation is frequent, in some cases excessive.

After the appearance of the local symptoms the anæmia develops. In addition to increasing pallor, the common symptoms of tinnitus aurium, palpitation of the heart, and dizziness are usually present. Emaciation is not marked in the beginning, and sometimes the subcutaneous fat is well preserved to the end.

Œdema is an almost constant symptom, beginning in the eyelids, later becoming general. The color of the skin is pale, yellowish, or greenish yellow. Even in negroes the pallor can be recognized by the grayish color of the skin and lips. The scleræ are usually brilliant. When cardiac weakness occurs cyanosis may alter the appearance.

The pulse is small, frequent, often intermittent. The carotids pulsate visibly. Murmurs can be often heard over the arteries and veins. Dilatation of the heart is not infrequent.

The blood is pale red or grayish red. The red blood corpuscles are pale. Poikilocytes are frequent; micro- and macrocytes not so numerous. The red corpuscles have been found reduced to as low as 1,250,000, or even 850,000, to the cubic millimetre. The hæmoglobin is correspondingly reduced. The leucocytes may be present in ordinary quantities or there may be leucocytosis. Myelocytes occur, and in Blick-

[1] Zinn and Jacoby have found that African negroes may have large numbers of parasites without showing symptoms—an important fact with reference to pathology and hygiene (*Berliner klin. Wochenschrift*, No. 36, 1896).

[2] *Volkmann's Sammlung klin. Vorträge*, Nos. 255, 256, 265.

hahn's case the eosinophile and basophile cells "were so numerous as to awaken the suspicion of the case being one of myelogenous leucæmia."

The respiration is frequent and dyspnœa is usually present.

In the advanced stages of the disease the anæmia leads to increased disturbance of the digestive functions. In this stage pica often occurs. There is often a craving for unripe fruit and for acids. Allotriophagia is rare, but dirt-eating, which has given one of the names the disease bears, may be present. It seems to be more common in children and in negroes, who even without anchylostomiasis may be dirt-eaters. Lutz thinks it a symptom rather than a cause of the disease, though so common as to be almost pathognomonic.

The stools are sometimes bloody, sometimes colored by clay. Bloody stools do not occur in every case, and among the St. Gothard tunnel cases were comparatively infrequent. It must be remembered that blood may be present, but altered or so intimately mixed with the fæces as not to be easily recognized. Mucus, usually intimately mixed with the fæces, is frequently present. In the stools large numbers of Charcot's crystals are often found, but, as Lutz has shown, are not pathognomonic.

The most important constituents of the fæces are the eggs of the parasites. These are so uniformly mixed with the fæces that the examination of a small quantity gives a comparatively accurate idea of the whole. After the use of anthelmintics the eggs may disappear for a few weeks, and then reappear, making it probable that the parasites have been injured, but recovered again.

The appearance of the eggs is so characteristic that they can hardly be mistaken for any others. Those of oxyuris are much like them, but differ in being less symmetrical, and frequently show the young embryo within them. The parasites themselves are rarely found in the fæces.

In the further course of the disease the results and symptoms of anæmia are prominent. In men there is impotence, in women amenorrhœa. If conception occurs, the infants are likely to be cachectic or to have rickets. Children with anchylostomiasis show retarded development. Fever may occur in the later stages. Often there is subnormal temperature. Rare symptoms are retinal hemorrhage and pain in the sternum, like that sometimes noticed in leucæmia.

The COURSE of the disease is chronic. Anæmia and dropsy progress until life is cut short either by exhaustion or by an intercurrent disease. A common complication is tuberculosis. Œdema of the brain is a not uncommon complication at the end.

DIAGNOSIS.—The diagnosis can only be made by an examination of the fæces and the finding of the eggs. This examination should therefore always be made where there is an unexplained anæmia. When a history of exposure is known or when the disease is endemic its discovery is not difficult.

PROGNOSIS.—The prognosis depends largely on the condition of the patient at the time the diagnosis is made. In mild cases recovery soon follows the removal of all the parasites, and even severe cases sometimes show complete recovery. Organic changes modify the prognosis as to complete recovery according to their nature.

PROPHYLAXIS.—The prophylaxis of anchylostomiasis includes the

prevention of the introduction of the worm in healthy localities, and the prevention of infection in places where the parasites are present.

Where the conditions for infection are favorable, as in brickyards, canals, and tunnels, care should be exercised to prevent the introduction of infected laborers. A history of the previous residences of workmen, if necessary an examination of fæces, might save much time and money. In all such operations the greatest care should be exerted in regard to the location, construction, and use of closets. The drinking water should be boiled. The danger of eating with soiled hands should be made clear.

TREATMENT.—Of remedies for the removal of anchylostoma, male-fern has been extensively used and is often efficient. As in the case of tape-worm, it often fails. In Italy very large doses of the oleoresin have been employed, but to-day doses larger than ten grammes (two and a half drachms) are rarely used. The preliminary treatment should be carried out as in tape-worm. Recently thymol has been used with great success. Bozzolo, who introduced it, used doses as large as two to ten grammes daily. Lutz found the best results by giving two to three two-gramme doses two hours apart, after a calomel purge. Large doses are followed by thirst, burning pain in the stomach, difficulty of urination, and burning in the urethra. Nausea is looked on by Lutz as a contraindication.

After the removal of the worm, which must be controlled by examinations of the stools, the anæmia or other effects must receive appropriate treatment.

Ascaris lumbricoides; Round-worm (Long round-worm); Lumbricus.—The round-worm is cylindrical, tapering toward both extremities, when fresh of a yellowish or grayish red color and a peculiar, disagreeable odor. The head end bears three papillæ. The females are 20 to 40 cm. in length, about 5 cm. thick; the tail end is straight and conical. The vulva is about the junction of the middle and the anterior thirds of the body. The ovaries are very tortuous, when straightened out about ten times the length of the body. The uteri, two in number, are nearly straight. The male is 15 to 25 cm. long, about 3 cm. thick; the posterior end is conical, curved toward the ventral surface; the two genital spicules are curved. The round-worm is one of the most prolific parasites. It has been estimated that a single female may contain sixty million eggs. The latter are elliptical, with thick transparent shells, 0.05 to 0.07 mm. long, 0.04 to 0.05 mm. wide.

The round-worm is one of the commonest parasites of man. It occurs in all parts of the world, more frequently in warmer regions. It is commonest in childhood. It occurs usually in small numbers, though in some cases many hundreds have been present.

The eggs of ascaris develop, after somewhat long periods of incubation, in water or moist earth. The vitality of the eggs is not seriously affected by freezing nor by drying for a short time. In a moderate temperature the time required for the development of the embryo is from thirty to forty days. The embryos are also extremely resistant to external agencies. After various negative experiments, Grassi, later Calandruccio, Lutz, and Epstein were able to produce infection by feeding embryonic eggs. In Grassi's experiment on himself it required

five weeks for the embryos to develop into sexually mature eggs. These experiments definitely settled the question of a secondary host, formerly thought necessary. Lutz showed that infection could only succeed when the embryos were still within the mulberry-like outer shells. The latter resist digestion in the stomach, but probably break in the intestine, and the embryos then develop into mature worms. In natural infection the eggs may be derived from water or from food accidentally contaminated.

The idea generally held by the laity that delicate persons are more frequently the hosts of ascarides is not borne out by facts. On the other hand, the popular idea that insane persons are often infected is partly correct, but this can usually be traced to filthy habits. More cases are observed in the fall than in other seasons, no doubt depending on the ripening of the eggs in the warm season.

The round-worms usually live in the small intestine. They sometimes get into the stomach or the colon, or even into distant parts of the body, through natural or artificial passages, as will be mentioned later.

Symptoms.—Ascarides, like other worms, may be present even in considerable numbers without causing any symptoms. In other cases there are symptoms such as anorexia or bulimia, nausea, salivation, irregular pupils, night-terror, irregular bowels, colic, sometimes blood in the stools, or malnutrition. The abdomen may be distended and sensitive. In children the face may be swollen, the eyelids blue. Pruritus, especially itching of the nose, is not uncommon. In some cases the symptoms of disturbed sleep and grinding the teeth during sleep, so dreaded by the laity, are present. These symptoms should properly raise the suspicion that the patient has worms. As, however, they may occur in other diseases the diagnosis of worms should only be made when the examination of the stools shows the presence of eggs or worms, and even then a full examination of the patient must not be neglected, as there may be another and more serious disease.

Various symptoms and complexes of symptoms have been ascribed to the presence of ascarides, especially nervous symptoms like chorea, epileptic attacks, and other convulsive diseases. In many cases the severe symptoms are due to other causes, but enough cases have been reported by trustworthy observers to make it at least unwise to discredit too rudely all the tales one hears in practice. In some cases of convulsive disease the local irritation of the worms may bring on an attack, even if it does not originate the disease.

When the worms are present in large numbers, they are most likely to cause abdominal symptoms. These may come on without any cause, but sometimes seem to be due to the eating of irritating food. Occasionally the parasites cause localized erosions or ecchymoses of the intestinal mucous membrane; in some cases chronic enteritis. In a case quoted by Mosler and Peiper a large mass of ascarides caused an intestinal obstruction.

Demme and others have reported severe anæmias, having some of the characteristics of pernicious anæmia, as the result of ascarides.

If the indirect symptoms are due to reflex action, this may be from the irritation of the worms in the intestine, but is more likely to occur

when they wander into the stomach. The usual condition is one of rest, the parasites retaining their relative positions in the intestine by the aid of the slightly spiral shape they assume. For various reasons they wander, and may then be carried out of the intestine. Wandering may be due to the sexual instinct of the worms. They are especially likely to wander when the host has a serious illness, especially a febrile disease. According to the observations of Perroncito, rise of temperature up to 45° C. accelerates the activity of the worms. Carried into the colon, they may be passed with fæces or may come away spontaneously, especially at night. When they get into the stomach, nausea and vomiting usually follow, in the course of which the worms are ejected, but they may crawl out of the nose or mouth without previous vomiting. Davaine mentions old reports according to which the worms got into the Eustachian tube or the lachrymal duct. More serious is it when the parasites get into the trachea or larynx. A number of such cases have been reported, but in the opinion of Mosler and Peiper the parasites in some cases have entered the air-passages after death. The symptoms in actual cases have been severe and rapid in their course. Coughing is excited by the first contact of the parasite with the laryngeal mucous membrane. In case the parasite is caught in the glottis, death occurs from suffocation; if it passes down, a fatal bronchitis or sometimes gangrene of the lung follows. In a case of Mosler's there were intense apnœa, complete aphonia, and suffocation. Examination showed the pointed end of a round-worm, the extraction of which was fortunately possible. The diagnosis in such cases presents great difficulty unless it is known that worms have been vomited. In cases in which the diagnosis was not complete but there was evidently a foreign body, tracheotomy has been performed, but, as a rule, without saving the patient.

Round-worms seem to have a liking for crawling through narrow orifices. They have been found in rings or beads swallowed by accident. From a similar propensity they sometimes enter the ducts leading into the intestine. In only a few cases have they been found in the pancreatic duct, but in a greater number in the ductus choledochus, the gall-bladder, hepatic ducts, or liver. Davaine has collected 37 such cases, Leuckart 8 more. In some of the cases it seemed from the absence of symptoms that the worms had entered the ducts after the death of the host. In some cases the number of worms is large—eighty in a case reported by Kartulis. A diagnosis during life seems never to have been made. Post-mortem, dilatation of the ducts, inflammation, abscess, and rupture of the cavities containing the parasites have been noted. In children especially, jaundice, fever, convulsions, and pain in the liver should lead to the suspicion of worms and to an examination of the fæces for the eggs. Ascarides have been found in the appendix vermiformis.

Round-worms do not bore through the wall of the normal intestine, but have frequently been found in the peritoneal cavity in cases dying with ulcerative disease of the intestine. Lutz has reported an instructive case in which it seemed at first that the worm had made a passage, as the intestine showed but slight alteration. It soon became evident from an epidemic which followed that the case was one of typhoid fever with insignificant local lesions. Fatal peritonitis usually follows, but in

some cases the inflammation is circumscribed, and the parasite eventually appears by way of the bladder, vagina, or uterus. Ascarides have been also found, after complicated adhesions and perforations, in hernial sacs, in the pleura, the spleen, or the kidneys. The "worm abscesses" occasionally found in the abdominal wall are usually sequels of ulcerative diseases of the stomach or intestine in which the worms appear by accident.

In the last century a form of fever resembling typhoid was described as due to lumbricoid worms—the "fièvre putrido-vermineuse" or "gastro-vermineuse" of older French authors. A. Chauffard has recently reported a case which he claims is of this kind. In this case there were thirty-nine worms, the longest 32 cm. long. The diagnosis of "lumbricose à forme typhoide" was made after the patient vomited a worm. There were present the typhoid condition and enlargement of the spleen, with other symptoms of typhoid fever, but no spots.

Diagnosis.—The diagnosis of round-worm can only be made after finding the worms or their eggs. The eggs are usually intimately mixed with the fæces and in large numbers, but if the worms are young or if only male specimens are present, the eggs of course will be absent, although the parasites may produce symptoms. If eggs are absent because of the immaturity of the worms, a few weeks' time will reveal their presence.

Prognosis.—The prognosis in cases of round-worm is favorable. The fatal results due to wandering are extremely rare in comparison with the great extent of the disease. Owing to the tendency to wander in febrile diseases, and the possibilities of rupturing the intestine or of getting into ducts, etc., it would be proper in the early stage of such disease in a person known to have round-worms to carry out prompt anthelmintic treatment.

Prophylaxis.—The prevention of round-worm is best carried out by the proper disposal of fæces. Next to this in importance is the prevention of infection by eggs on the ground. Infection by water is probably not common, and can be altogether avoided by preventing the contamination of drinking water and by having it sterilized. From the nature of things ascarides will long remain possible in children and others careless as to what they put in their mouths.

Treatment.—Ascarides usually yield to santonin. This can be given in lozenges or mixed with sugar in the dose of five grains to an adult, two grains to a child two years old, followed by a purgative. Syrup of senna is also a useful vehicle. A preferable plan in most cases is to give smaller doses two or three times a day—one half to one grain to a child two years old. On the second or third day a cathartic, such as calomel, should be given and the rectum washed out by large enemata, to which five drops of benzin may be added (Mosler).

The symptoms of santonin-poisoning—yellow vision, yellow urine, depression, hebetude, vomiting, and convulsions—are most likely to occur if the drug is taken on an empty stomach. For the convulsions chloroform inhalations should be used after purgatives have been administered to remove any unabsorbed santonin from the intestine.

Santonin is so much more effective than other remedies for round-

worm that it is not necessary to do more than allude to spigelia, kamala, turpentine, and other drugs occasionally used.

Ascaris mystax, a parasite of dogs and cats and some wild animals, has occasionally been observed in man. In two cases it has been coughed up. This worm is much smaller than ascaris lumbricoides, the males being from 45 to 60 mm., the females 120 to 180 mm., long. The head end is somewhat spiral, with two wing-like appendages at the sides. The eggs are globular, with thin shells, from 0.068 to 0.072 mm. in diameter.

The development of ascaris mystax is like that of the lumbricoid worm.

Oxyuris vermicularis; Ascaris vermicularis; Pin-worm; Seat-worm; Thread-worm; Ascarides.—This common parasite occurs everywhere. It is a small, white, cylindrical worm, tapering toward both ends, somewhat expanded at the head. The mouth has three retractile papillæ. The males, 3 to 5 mm. long, are curled up at the tail end, where they bear six papillæ. The females are 10 mm. long, 0.6 mm. wide. The anus is just in front of the tail end, the vulva in the anterior third of the body. The eggs are oval, thin-shelled, 0.05 mm. long, 0.02 mm. wide, usually flattened on one side.

Fig. 23.

Eggs of oxyuris vermicularis; × 275 (after Eichhorst).

Fig. 24.

Oxyuris vermicularis; natural size (Eichhorst.)

The eggs are usually passed outside of the body after the expulsion of the females. These contain from ten to twelve thousand eggs, which can sometimes be seen leaving the body of the parent worm in a mass. The embryos in the shells have great powers of resistance, and after being dried for months may be brought to full development if placed under the proper conditions as to heat and moisture. At times the eggs are extruded in the intestine of the host, and may be passed in various stages of development, or may be found if looked for around or within the anus. If the eggs obtain entrance to the human intestine, the shells are dissolved, the embryos set free, and the worm finally developed into a sexually mature parasite. According to Leuckart, the development of oxyuris in the intestine is rapid, so that in two weeks after feeding the eggs, worms of 6 to 7 mm. in length have been passed.

Copulation takes place in the small intestine, where the males usually remain. The females soon get into the cæcum, where they remain until the eggs are developed. After this they begin to wander toward the rectum and anus. Some of them are expelled with the fæces, others wander out spontaneously.

Etiology.—Though oxyuris is more common in children than in adults, and in persons of filthy habits than the reverse, it is nevertheless more widely distributed in different ages and classes than any other helminth (Lutz). The disease is often of brief duration; in some cases, however, it has lasted for years—in a case in the Greifswald clinic forty-three years.

The mode of infection varies. The eggs may be dried by sun and wind and scattered over objects of various kinds. Vegetables, berries, greens, and fruit may thus be contaminated. It is possible they are taken up by flies and other insects and transported by them. Water may serve as a source of infection, though the eggs soon die in it.

The large numbers of pin-worms sometimes observed can only be explained by reinfection, a process easily understood from one of the symptoms of the disease. From the unavoidable scratching, if in no other way, eggs may get under the nails, where they have often been found, and ultimately get into the mouth. In the same way the eggs may be conveyed to bedfellows or playfellows or from a father or mother to a family of children. In asylums oxyuris is often a formidable pest.

Symptoms.—The usual symptoms of oxyuris are direct and unmistakable, though often overlooked by reason of diffidence on the part of patients and otherwise. The commonest symptom begins in the night, after the patient has gone to bed, and consists in burning or itching of the anus. This may vary, according to the number of the parasites, from a mild uneasiness to an irresistible pruritus. The symptoms sometimes come on with great regularity, and have even led to the suspicion of malaria and been treated by quinine. The cause of the periodicity, whether depending on the condition of the intestine or the quietness or warmth of the host, is not known. Occasionally the irritation is greater after defecation. Coffee, tea, and alcoholic drinks are said to increase the activity of the worms.

If large numbers of parasites are present, a catarrhal condition of the mucous membrane develops. The hemorrhoidal veins may become dilated. These changes in turn offer the parasites more favorable conditions than the normal mucosa. As the result of the catarrh the stools become irregular, diarrhœal, often with slight blood streaks. Defecation is painful.

The local irritation in the rectum often affects the genitals, causing in males frequent emissions or itching extending to the glans. In women the parasites have a tendency to wander along the perineum into the vagina, causing great itching, often catarrhal inflammation, and not rarely leading to masturbation. Rarely they get into the uterus or the bladder.

In rare cases the parasites have wandered into the stomach or the pharynx.

Besides the local effects of oxyuris, all kinds of reflex symptoms have been described, including convulsions of various kinds and paralysis. The extent to which sensitive persons may be affected by the local irritation is of course very great.

Diagnosis.—The diagnosis of oxyuris is usually not difficult, provided the requisite examinations are made. The anus should be in-

spected, and the parasites may sometimes be seen then in active motion. The skin around the anus is reddened or excoriated; the mucous membrane red and moist. The fæces usually contain an excess of mucus, and the worms may be often seen on the outside of the masses.

If the worms are suspected, but not found at the first examination, an injection of cold water should be given, when some of the parasites will usually come away. The examination of the stools for eggs is usually negative, and therefore of little practical value.

Prognosis.—The prognosis is good, though recovery is sometimes slow, and as long as worms are present a reinfection may take place.

Prophylaxis.—Cleanliness is the most important thing in the prophylaxis of oxyuris. Details regarding prevention of infection follow from the facts above set forth regarding the development and etiology.

Treatment.—In the treatment of oxyuris cathartics occupy a prominent place, and next to them anthelmintics. Of the latter, santonin is one of the most important. A useful formula originated by Mosler is as follows:

℞. Santonini, .2;
Olei ricini,
Syrupi rubi idæi, āā. 50.0;
Chloroformi, 1.0.—M.
Sig. One or two tablespoonfuls in the evening.

In oxyuris Lutz has had good results from thymol, given internally and in enemata.

With all internal remedies large enemata should be used daily to assist in the evacuation of all the worms.

For the relief of itching local applications of fluid extract of hamamelis are useful. Cold enemata frequently cut short the paroxysm.

TRICHINOSIS.

By GEORGE DOCK, M. D.

Synonym.—Trichiniasis.

Definition.—Trichinosis is infection by the trichina spiralis, characterized especially by disturbances on the part of the alimentary canal and the striped muscles, with general symptoms.

Etiology.—Trichina spiralis (Owen) is a nematode worm, found only as a parasite of animals, of which very many genera serve as hosts. Its importance as a human parasite depends on its frequent occurrence in hogs. Rats also play an important part in the spread of trichinæ. They are frequently the hosts of trichinæ, and their nomadic habits and cannibalism tend to spread the disease. How rats originally became infected is an open question, but at present they have abundant opportunity, eating as they do the offal of slaughter-houses. Hogs in turn kill and eat rats, and in this way, as also from eating excrement of other hogs or offal of abattoirs, introduce the parasites into their intestines.

Trichinæ have a wide geographical distribution, but the proportion of infected animals (hogs) varies much in different parts of the same country. In general, hogs raised in cities more frequently contain trichinæ than those in the country. Owing to greater care in the disposition of offal, this disproportion is not so great as formerly, although a comparatively recent report from Massachusetts shows 10–14 per cent. of infected animals in the city as compared with 2–3 per cent. in the country. Trichinosed hogs are numerous in the United States, the proportion being estimated as high as 2–3 per cent. Notwithstanding this, trichinosis in man is comparatively rare in this country. This is due to the fact that the meat is seldom eaten raw, and the preserved meats, both salt and smoked, are, as a rule, thoroughly "cured," so that the parasites are rarely swallowed alive.

In hogs the trichinæ perform migrations similar to those in man. This is as follows: When meat containing live "muscle" trichinæ is eaten the parasites are set free in the process of digestion and enter the intestine. Here they grow larger, and in about three days become sexually mature. They then procreate, and by the seventh day the embryos are set free. These are born alive, breaking the shell *in utero*. They then migrate, and finally enter the muscle fibres, in which they ultimately become encapsulated.

Adult or *intestinal trichinæ* are minute, thread-like worms. The female measures from three to four millimetres in length; the male, about one and a half millimetres. They are narrow and pointed in

front, thicker at the posterior end. At this end the male has two papillæ, which serve a purpose in copulation. The internal organs are very simple. Most of the body is occupied by the organs of generation. The male intestinal trichinæ die soon after procreating. The females live six to eight weeks in the intestine, during which time they produce embryos to the number of from four hundred to a thousand or more.

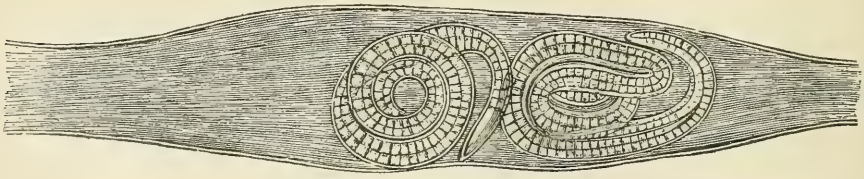
The embryos begin to migrate as soon as they leave the uterus, and in a very short time disappear from the intestine. It was formerly supposed that the migration was altogether active, the embryos boring their way through the intestinal wall and so reaching all parts of the body by interstitial travel. On account of their early appearance at distant points some have supposed they were transported by the blood, although the fact that they are rarely found in the blood opposed that idea. Recently Askanazy[1] has shown that the female adults push themselves into the villi of the intestines, and that the embryos are really born in the lymph-vessels, from which they reach the muscles.

During their travel the embryos grow slightly, but do not become sexually mature. Reaching the muscles, they enter the sarcolemma sheaths and become encapsulated.

Once encapsulated, the trichinæ can retain their vitality for long periods. It has been claimed they can survive for thirty years; that they have been found alive after eighteen years seems definitely proved. Trichinæ are resistant to external influences outside of the body also. They can live many months in decomposing meat. They resist the freezing temperature as long as two months. They are killed at once by a temperature of 140° F., but survive lower temperatures, even if long continued. In the usual curing solutions trichinæ are killed within six weeks in thin pieces of meat, but in thick pieces can exist as long as four months. As shown beyond possibility of question, the salt and smoked meats prepared for export in this country rarely contain live trichinæ, but the characteristics mentioned above account for the clinical importance of the parasites.[2]

Pathological Anatomy.—In the striped muscles the trichinæ enter the primitive fibres, causing a myositis which does not differ greatly from that due to other irritants. The affected muscles are pale

Fig. 25.



Muscle-fibre with trichinæ (Heller).

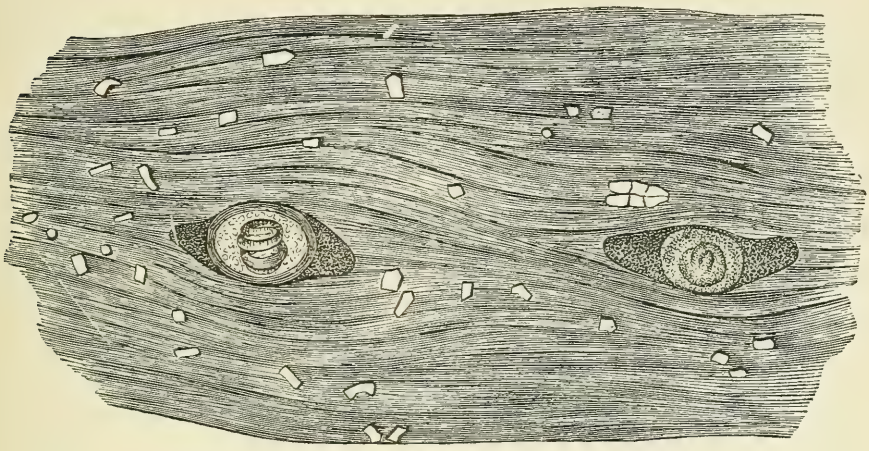
at first, later cloudy. The muscle fibre in the vicinity of the parasite undergoes granular degeneration, transverse fragmentation, and some-

[1] *Centralblatt für Bakteriologie und Parasitenkunde*, xv., 1894, p. 225.

[2] Regarding this important economic question, see the articles of Wasserfuhr and C. Fränkel, *Deutsche medicinische Wochenschrift*, 1891, Nos. 22 and 51.

times hyaline change. In a few days the trichinæ, which have reached a length of about one millimetre, roll up (hence the specific name); the sarcolemma bulges out, becomes thickened, and contains a large number of nuclei. Beyond the parasite the sheath is narrowed. By about two months a rounded oval capsule is formed, containing from one to three or four trichinæ. Calcification takes place in the capsule at a later

FIG. 26.



Encysted trichinæ, with calcification of the capsule (Heller).

period, and is usually complete in from a year to a year and a half. The calcified opaque capsules appear to the naked eye as grayish specks in the muscle. Occasionally the encapsulated trichinæ die, become calcified, granular, and difficult to recognize.

Trichinæ show a preference for certain muscles. The diaphragm and its pillars, the lumbar muscles, the tongue, masseters, intercostal and laryngeal muscles are especially affected. The parasites are most frequent near the insertions of the muscles. A case has been reported in which the infection was largely confined to one quadriceps femoris, producing a large tumor.[1] The heart muscle is almost always free from the parasites.

Other anatomical changes are—catarrhal enteritis, sometimes hemorrhagic, with swelling of the mesenteric glands and sometimes peritonitis (in recent infections). Fatty degeneration of the liver, kidneys, and heart and hypostatic pneumonia sometimes occur, and are due to changes induced by the parasites or to intoxication.

The number of trichinæ found in different cases varies enormously. In many cases they have been estimated by millions. On the other hand, in a fatal case in Leipzig (cited by Brass) nine men examined hundreds of preparations and found only one trichina in the muscles. Usually infected human beings contain more trichinæ than the animals from which they were infected. Examinations of human bodies and animal experiments prove that there is no constant relation between the number of parasites in the body and the symptoms produced. In ani-

[1] Finger, *Virchow's Archiv*, Bd. 137, p. 376.

mals, as well as in man, a number which will cause marked symptoms in one individual may produce no symptoms in others, even when nothing occurs (such as diarrhœa, vomiting, or treatment) to prevent the development and migration of the parasites. In other words, predisposition plays a part in the pathology of trichinosis.

Symptoms.—The symptoms of trichinosis vary much, but on the whole form in most cases a characteristic picture, most readily recognized when a number of cases occur at the same time.

The first symptoms sometimes appear soon after ingestion of the infected meat, and consist of pain in the abdomen, colic, loss of appetite, nausea, vomiting, and diarrhœa, with bloody stools. These symptoms may be so severe as to suggest the existence of typhoid fever, as in the famous case of Zenker, which led to the discovery of the disease. In some cases the patient dies in a few days with choleraic symptoms. Early diarrhœa and vomiting are more frequently observed in children than in adults.

Usually the first few days after infection are without symptoms. Toward the end of the first week malaise, anorexia, and alternate chills and flashes of heat are noticed. The early symptoms are due partly to the trichinæ in the intestine, but on account of the general symptoms which appear before the embryos have time to reach the muscles it has been supposed, since the time of Friedreich, that the parasites produce a toxic substance which is set free in the rupture of their capsules. Besides the symptoms mentioned, sweating is common at this time, and as a result of the sweating, sometimes too from fever, there is thirst. At this time diarrhœa may occur, with choleriform stools and even with collapse and death.

In the second week the symptoms of migration are present. Muscular weakness and pain are the prominent symptoms. The pain in the beginning is rheumatic in character. It is increased by motion or pressure. The muscles of mastication and respiration are especially affected, but those of the body and extremities are not altogether spared. The muscles swell, become hard and elastic or rigid as boards. Contractions and contractures occur, so that the extremities cannot be moved. Pain in the respiratory muscles renders breathing difficult and shallow. Catarrhal secretions gather in the bronchi and trachea, adding to the difficulty, and even leading to fatal dyspnœa. Difficulty of swallowing, trismus, hoarseness, and aphonia may occur. If the muscles of the eye are affected, motion of the bulb is painful and difficult. Nystagmus and mydriasis have been observed. Deafness may occur from affection of the auditory muscles.

A characteristic symptom is œdema of the face, usually beginning in the eyelids. Choked disk has been observed, and also œdema of the orbital tissues, causing exophthalmos. Later there may be œdema of the extremities. The œdema has been ascribed to thrombosis of veins, toxæmia, and obstruction of lymphatics from within or without.

Fever is usually present. It is, as a rule, high, remittent, and resembles in its course the typhoid fever temperature. Usually the pulse is increased in frequency in proportion to the temperature.

The severe sweating is very characteristic, and may last through the whole course of the disease. Hyperæsthesia and anæsthesia of

the skin have been noted. More frequent are urticaria, herpes, and pustules.

Sleeplessness is common; neuralgia not rare; the patellar reflex is sometimes absent.

In fatal cases delirium, coma, and collapse appear toward the end.

The disease is of variable duration. In some cases recovery takes place after the symptoms of intestinal trichinosis, in others in from three to four weeks. Death may occur early, as stated, or the patient may die of exhaustion, or of pneumonia, or of some other complication in the sixth to the eighth week. Most fatal cases end before the sixth week. Convalescence is unusually slow.

COMPLICATIONS AND SEQUELÆ.—Among the numerous complications bronchitis and pneumonia are common and important. In some cases ascites or dropsy of serous cavities has been observed. Hiccough is sometimes a troublesome symptom, supposed to be due to irritation of the diaphragm. Hemorrhages from the nose, intestine, and genitals occur. In the celebrated Hedersleben epidemic abortion occurred twice, and has been observed elsewhere. Trichinæ have not been found in the fœtus.

As a late sequel a tendency to obesity has been observed. Muscular weakness, stiffness, and pain are common. Usually the urine shows no particular symptoms. Polyuria and albuminuria have been noticed in a few cases. Desquamation of epidermis and loss of hair have occurred.

DIAGNOSIS.—Comparatively easy when a number of cases occur together with most of the important symptoms, the diagnosis in a single case or in the first case of an epidemic often presents great difficulty. Even when the early gastro-intestinal symptoms occur simultaneously in a number of persons who have been eating the same meat, the cases may be considered as ordinary cases of meat intoxication. If part of the meat has been kept and shows trichinæ, the diagnosis cannot be long in doubt. Examination of the stools in such cases is of comparatively little value, as it is usually negative. When muscular weakness and pain come on after the preliminary symptoms, the possibility of trichinosis must be considered. When to these symptoms œdema of the face is added the diagnosis is almost beyond doubt.

Many mild cases of trichinosis are no doubt mistaken for muscular rheumatism. In severe cases the number of muscles affected and the other muscular symptoms mentioned serve to distinguish the two diseases. Other forms of infectious myositis can be excluded by the distribution of the disease, the œdema, and other symptoms. The œdema of nephritis can be excluded by the fact that albuminuria is rare in trichinosis, or if present the amount of albumin is small. Typhoid fever is to be excluded by careful attention to the symptoms of both diseases, but when the muscular symptoms and œdema of trichinosis are absent the discrimination may require time. A history of the habitual use of raw pork is an important point in many obscure cases when remains of suspected meat cannot be examined. The diagnosis can sometimes be made by examining the muscle of the patient, but this is not altogether reliable. "Harpooning" is especially unreliable, and, if it is considered necessary to examine the muscle, the best way is to cut out a small piece with aseptic precautions. This can be done

under cocaine. In examining fresh specimens (taken from the points of predilection) pieces of muscle should be teased out flat or mounted in a compressor, and examined with a power of from forty to seventy diameters. Smoked meat is most readily examined by making a number of free-hand sections with a razor and examining in salt solution.

In a case of trichinosis examined in Osler's clinic[1] the blood showed an increase of eosinophile cells amounting to 68 per cent., with 30,000 leucocytes per cubic millimetre. There were large numbers of eosinophile cells in the lesions in the muscles. The importance of further investigations with a view to aid in diagnosis is evident.

Prognosis.—The death rate of trichinosis varies in different epidemics from 2 to 30 per cent. According to statistics gathered by Osler, out of 456 cases reported in the United States 122 died. Children are more favorable subjects on account of their greater tendency to early diarrhœa.

Prophylaxis.—In the prevention of trichinosis perfect cooking of pork is the only reliable method. The meat must be subjected to a temperature of at least 140° F. long enough to coagulate it. (It is said that a twelve-pound ham does not attain this temperature in its centre even after being boiled for three hours.) Inspection of meat is to be encouraged for many reasons, but in regard to trichinosis it must be remembered that more cases of trichinosis occur in Germany from eating inspected native pork, which rarely contains trichinæ, than in the United States, where trichinous hogs are numerous and inspection seldom carried out. The reasons for this are obvious. In the first place, the habit of eating raw pork is very common. Inspection of pork for trichinæ is tedious work. The parasites may escape even careful search, and when many negative examinations are made the inspector naturally loses interest. The inspectors, therefore, require constant checking. In some parts of Germany an inspector is not allowed to make more than ten examinations (sixty square centimetres to be examined in each) in a day. In other places this number is exceeded.

Hogs found to be infected should not be used as food in any form, but either burned or used for glue or soap. The offal must be burned always, and not buried. Hogs should never be fed on the offal of slaughter-houses. Hog-pens should be protected from rats if possible. By these methods the proportion of trichinous hogs can be reduced, but the disease not eradicated, so that the public should understand that complete cooking is the only safeguard except abstinence.

Treatment.—The treatment of trichinosis varies with the stage of the disease. If a patient is seen soon after eating meat recognized as trichinous, emesis should be provoked or the stomach washed out. Within the first few days a purgative may drive out all the trichinæ before migration begins, and so stop the disease. Even at later periods it is rational to give purgatives, as the intestinal trichinæ live six weeks or more, and one may thus lessen the number of embryos. Vermifuge remedies have been used, but ordinary cathartics are perhaps as useful. Among cathartics castor oil, calomel, and senna and Epsom salts are to be preferred. Purgation may be repeated during the course of the dis-

[1] *Johns Hopkins Hospital Bulletin*, No. 73, April, 1897.

ease. Irrigation of the colon is also a procedure which may aid in clearing the intestine. Numerous remedies are claimed to have specific action on the parasites. Perhaps the one most worth using is glycerin given in a single dose of three ounces or hourly doses of one teaspoonful. Benzin has also been used in the dose of one drachm twice daily on an empty stomach, but Mosler, who introduced it, has given it up. Alcohol in large amounts, in concentrated form (brandy or whiskey), is useful along with purgatives. The advice sometimes given that alcoholics be used regularly with the meals as a prophylactic is not to be taken seriously.

After the muscular symptoms appear the treatment must be symptomatic, the chief indications being to relieve pain, to secure sleep, and to maintain strength. The diet must be nutritious. For the pain morphine is often necessary, but it is proper to try remedies like phenacetin. Hypnotics must be used to produce sleep. For the sweating atropine is usually effective. Warm baths often have a very beneficial action in cases of marked muscular pain, and in some cases prolonged or permanent baths have had happy results. Other symptoms and complications must be treated as if they were independent diseases.

FOOD-POISONING (BROMATOTOXISMUS).

By VICTOR C. VAUGHAN, Ph. D., M. D.

Introduction.

Untoward results frequently follow the eating of food which is ordinarily harmless. These ill effects may be due to a variety of causes. In the first place, certain plants and animals may at certain seasons of the year, or at some period of growth, or on account of the physiological activity of some organ, contain substances that are injurious to man, while at other periods these substances are not present. Thus, as we shall see, certain species of fish may be poisonous when used for food during their reproductive period. Secondly, plants and animals may absorb or feed upon substances which do not destroy their vitality or appreciably affect their health, but may act injuriously when transmitted to man. The flesh of quails and partridges may be poisonous when these birds feed upon mountain laurel. Thirdly, the plant or animal may be diseased and the active agent in the causation of the disease may be transmitted to man. Tuberculosis may certainly be transmitted to man in the milk, and possibly in the meat, of tuberculous cows. It is pretty certain that some of the epidemics of fish-poisoning are to be accounted for in a similar manner. Fourthly, food may be infected with specific pathogenic micro-organisms outside the animal body, and may then act as the bearer of this infection to man. That typhoid fever has been thus spread through the can of the milkman is well known. It is also highly probable that cholera, the bubonic plague, and other infectious diseases may be disseminated in the same way. Fifthly, food of various kinds may become contaminated with saprophytic bacteria that elaborate chemical poisons in the food either before or after it is taken into the alimentary canal of man.

It will be seen from the above that food may acquire harmful properties in diverse ways. It will also be evident that the term food-poisoning is to some extent inappropriate when employed to cover all these forms of harmful foods. However, I have thought it best to use it, because it most appropriately fits the majority of the cases falling under the observation of physicians in this country. In the discussion of a paper read by the writer before the Seventh International Congress of Hygiene and Demography, Blanchard proposed that the term *botulismus* be employed to indicate cases of food-infection, and the Spanish word *siguatera*[1] be used to cover those cases due to physiological poison. His statement was practically as follows:

"I wish to state that there are two distinct categories of intoxications due to the eating of the flesh of vertebrates:

[1] Pronounced *sig-wah-te'ra.*

"(1) *Botulismus* is an intoxication induced by meat invaded by microbes and the ptomaïnes elaborated by them. This term is applicable not only to disease caused by market meat, but also to that induced by preserved food.

"(2) *Siguatera* is an intoxication caused by fresh food not infected with bacteria, and in which the poisonous principles are leucomaïnes formed by the physiological activity of the tissues. I propose to designate this category of intoxication by the word *siguatera*, a name employed by the Spanish physicians of the Antilles to indicate poisoning by the eating of fish."

It is evident that these terms, used as proposed, do not cover all the forms of food-poisoning. Vegetable as well as animal food may be harmful. The term botulismus has been used to designate the complex of symptoms due to the eating of infected sausage, and it is hardly applicable to cases of poisoning from decomposed corn-meal or to those due to poisonous milk or milk-products. Certainly, it would be inappropriately employed should we use it to refer to ergotism or lathyrism.

The term "ptomaïne-poisoning" has been quite extensively used in recent years to designate cases of illness caused by the eating of infected food. This designation was adopted at a time when we believed that the most important poisonous products of bacterial activity were based on their chemical characteristics. A ptomaïne is a basic product of putrefaction, and, while it is true that the active agent in an infected food may be a base, this is the exception and not the rule. The more recent discoveries among the chemical products of bacterial origin have shown that the most potent poisons elaborated by these organisms are not properly classified among the ptomaïnes. In fact, we are by no means certain where they do belong chemically. We call them toxins, and wait for future researches to give us more exact information concerning their chemical composition.

I have thought that the term "food-infection" is preferable to that of "food-intoxication," because in the majority of instances the bacterium is the primary cause of the trouble, and certainly in the study of both the prevention and the cure of these cases this must be taken into consideration. Since the infection of food with harmful micro-organisms is, as has been stated, the most fruitful source of food-poisoning, in this country at least, I will give the greater part of the space allotted me to the discussion of this part of my subject.

I will first give my attention to the infection of food with saprophytic, toxicogenic germs. Instances of food-infection of this kind have apparently greatly increased within recent years. This increase has been only partly apparent and partly real. Many cases of illness that are now known to be due to food-infection were formerly believed to have their origin in some other cause. Only a few years ago we were seeking for the causation of the fearful mortality among infants from the summer diarrhœas in unknown meteorological and telluric conditions, but we now know that these diseases are solely due to food which has become poisonous on account of infection with harmful micro-organisms. The fact that foods containing bacterial poisons may act as gastro-intestinal irritants is now well known. Continued fevers, at times

resembling typhoid fever, may originate in the same way. Scarlet fever and other acute exanthemata may be closely simulated by the symptoms induced by infected foods. Septicæmias may have a like origin, and there is a form of septic pneumonia that has been found to be due to the presence of harmful bacteria in the food.

It is often impossible to draw a line between intoxication and infection in the study of the symptons of poisonous food. It is customary to say that the case is one of intoxication if the first symptoms appear within from two to four hours after the food is taken, but some of the toxins are very slow in their action, as has been demonstrated by experiments on animals, while, on the other hand, bacteria may multiply in the human body with astonishing rapidity. The relation of the germ to the production of the symptoms may be stated with reference to the infection of the food in one or the other of the following ways : (1) The chemical poison is formed solely in the food before it is taken ; (2) The germ may begin the elaboration of its poisonous products outside and continue the same within the body ; (3) The infection may not result in the production of poisons until the food is taken into the body.

It may happen that the infecting germ will not grow at a temperature so high as that of the body, and yet it may elaborate deadly poisons. In such a case the germ multiplies in the food and elaborates a chemical poison sufficient in amount and in virulence to endanger life. I imagine that instances of this kind are very rare, but that they are possible cannot be denied, and the " Iron Bridge " outbreak reported by Ballard seems to belong to this category. Twelve persons out of a household of fifteen partook at midday of veal pies made the day before and warmed up for the meal. Three showed the first symptoms after six or seven hours, four after from seven to ten hours, and the remainder later at night. It might be observed here that all of these would be regarded as instances of infection rather than of intoxication if we held to the old rule of making the period between the taking of the food and the appearance of the first symptoms no longer than four hours in intoxication, and yet Klein found in the veal pie a motile bacillus which would not grow above 32° C. Inoculations of warm-blooded animals with pure cultures of this bacillus were, of course, without effect, but when mice were fed with old cultures grown at ordinary temperatures they sickened and died, showing lesions in the stomach, intestines, lungs, liver, and kidney, but the living germ could not be found in the animals.

The second condition is the one usually observed in cases of poisoning with milk and milk-products. Even in these instances the germ, as a rule, does not thrive in the intestines unless it be supplied with the pabulum on which it grows best. This explains why the withdrawal of all milk from the food has proved so beneficial in these cases. The violent vomiting and purging which result are curative in their effects, inasmuch as they remove the infecting agent, and should not be checked unless there be danger to life from exhaustion.

When the third condition mentioned above exists, a true infection results. This is the case in those long-continued fevers which may resemble typhoid, and in septic pneumonia due to food-infection. Gaffky has reported a case of this kind, of which the following is a brief abstract :

"D——, the chemist of the Hygienic Institute at Giessen, did not feel well on the morning of October 10th, but in company with assistant B—— he visited Frankfort. During the day he had a severe headache, no appetite, and frequent chilly sensations. On returning to Giessen at night he was scarcely able to walk. On the next day he refused all food, was slightly delirious, and had one watery stool. On the 13th his condition showed serious infection. His face was red, his eyes sunken, his temperature 105.2° F., and he lay in a half-unconscious state. The tongue was heavily coated, the abdomen distended and painful on pressure. He had five dark-brown, later greenish, stools. The urine was concentrated, and contained 2 per cent. of albumin, as determined by Esbach tubes; it gave the diazo reaction and the indican reaction, and contained white blood-corpuscles and numerous granular casts.

From the 13th to the 17th the patient was stupid, but not delirious. The abdomen was greatly distended, and from twenty to twenty-four stools were passed each day, with great tenesmus. The temperature remained high, notwithstanding repeated one-gram doses of antipyrine. Sleep was broken and one gram of sulfonal was given at night. The urine remained as before, aud the pulse varied from 92 to 100.

From the 18th to the 20th the mental dulness was less marked. Appetite was somewhat improved, and the number of stools decreased to from eight to ten in twenty-four hours. The amount of albumin in the urine was somewhat decreased, and microscopic examination showed fatty casts and white blood-corpuscles. Small doses of opium were given by mouth and in suppositories.

On the morning of the 21st hemorrhage from the bowels, about 300 c.c. in amount, occurred. Several doses of opium were given and ice-bags were kept on the abdomen. After the hemorrhage there were three slightly bloody stools. From this time the improvement was slow, but, fairly constant. The fever disappeared October 29th.

After recovery marked anæsthesia of the anterior surface of the thigh developed, and remained for some weeks, the anæsthetic area gradually becoming smaller. The hair fell out, mental activity tired, and the eyes were easily fatigued for some months. Two workers in the same laboratory were affected in the same manner, but less severely. The only food or drink which these three men had in common was some uncooked milk taken on the morning of October 9th. D—— ordered the milk sent to the laboratory, drank the greater part of it himself, giving B—— a small cupful, and the servant drank a little left by the others. The cow that gave this milk was suffering from a bloody diarrhœa. Gaffky found in the stools of the cow and in those of the patients a small, highly virulent form of the bacillus coli, and to this he ascribes the ill effects. He supposes that some of the liquid discharges from the cow fell on the udder and thus found its way into the milk.

That Winckel's disease, a septic pneumonia, may be due to infection of the food with the bacillus enteritidis, first discovered by Gärtner in poisonous meat, has been demonstrated. Lubarsch has reported such a case in an infant. The stools were greenish and of bad odor. The child became cyanotic and the respiration increased to 60 per minute. Auscultation and percussion were negative in results. The breathing was wholly costal and the abdomen distended. The urine contained

neither albumin nor hæmoglobin. Post-mortem examination showed pneumonia of the left lower lobe, bilateral purulent bronchitis, atelectasis of the right lung, parenchymatous cloudiness of the kidneys, fatty infiltration and engorgement of the liver, and slightly enlarged spleen. All other pathological conditions were believed to be consequent upon the septic pneumonia. Plates made from the diseased organs developed only the bacillis enteritidis.

The Detection of Toxicogenic Bacteria in Suspected Foods.

I have been frequently called upon to examine food suspected of having caused untoward effects, and the method followed in these examinations may be of some interest. Whenever there is the slightest possibility that a metallic poison may be present tests for the same are made. This is always done with canned foods. However, when a teaspoonful or less of ice cream causes vomiting and purging, the idea that these effects can be due to zinc sulphate dissolved in the freezer or to artificially prepared vanillin used in flavoring is simply too preposterous to be entertained by any one acquainted with the quantities of these substances necessary to induce such effects. Ten years ago we went through with all the tests for metallic poisons in many samples of poisonous cheese and ice cream, but we no longer waste our time in this manner.

The examination of foods for bacterial poisons cannot be made except in a properly equipped bacteriological laboratory. It is my purpose merely to point out at this time the methods that may be followed. I assume that the one who undertakes work of this kind is already familiar with the ordinary technique of bacteriological research. The line of procedure will vary somewhat with the kind of food to be examined, the form in which it has been prepared, and the quantity supplied the analyst. All samples should be examined with as little delay as possible after the article has become the object of suspicion. When delay is unavoidable, further bacterial growth should be retarded in the mean time as far as possible by keeping the suspected article at a low temperature. Germs not present at the time of the supposed poisoning may be accidentally introduced, or non-toxicogenic bacteria may multiply to such an extent that the detection of the harmful organisms is rendered impossible.

As a rule, the quantity of the food supplied the analyst is not sufficient to allow of the detection or the isolation of the chemical poison directly. To try to find the poison in a few ounces of cheese or a small bit of meat by direct extraction is a task that would be undertaken only by one quite ignorant of the nature of these poisons. In all but exceptional instances, in which many pounds of the food are supplied, the portion that reaches the laboratory can only be regarded as the bearer of the germ to the activity of which the poison is due. This germ must be detected, isolated, grown in pure culture, and its toxicogenic properties demonstrated upon lower animals. It should be clearly understood that the most thorough study of the morphological characteristics of the germ and of the chemical properties of the poison will not suffice without an accompanying determination of the toxicological

action of the cultures. The infectious nature of the bacterium should also be studied.

It should always be borne in mind that the article of food has probably been through several hands before reaching the analyst, some of which may not have been germ-free. In the examination of pieces of meat and cheese the surface should be sterilized with a broad heated knife or other piece of iron. It has been shown that bacteria deposited on such surfaces penetrate slowly. Then with other sterilized knives sections should be made, and one or more small bits taken from the interior should be placed in sterilized bouillon. Not less than a dozen tubes should be inoculated in this way. Three of these should be grown aërobically at ordinary temperature, three anaërobically at the same temperature; three aërobically at 37° C., and three anaërobically at 37° C. It is quite essential that all these conditions of growth should be tried. Some of the toxicogenic germs grow best at relatively low temperature, from 20° to 25° C., and fail wholly to develop at 37° C. Others have their optimum growth at the last-mentioned temperature. Some develop only when freely supplied with air, and others only when the air is excluded.

In the examination of liquid and semi-liquid foods, such as milk, custard, cream, broths, and jellies, small bits or a few drops should be placed in sterilized bouillon and grown under the conditions already mentioned.

A growth having appeared in one or more of these tubes, the bacteria should be examined in hanging drops and in stained mounts. If more than one organism be present, plate cultures should be made and each germ should again be grown under the conditions mentioned.

The infectious character of each organism should be tested on the lower animals—(1) by feeding, (2) by subcutaneous inoculation, (3) by intraperitoneal inoculation, and (4) by intravenous inoculation. The animals generally employed in these experiments are white mice, white rats, guinea-pigs, kittens, and rabbits. A given germ may be toxicogenic to one of these animals and not to the others. Mice and kittens are specially suitable for feeding experiments. Young kittens are quite susceptible to most of the bacterial poisons found in milk and its products. The quantity of the bouillon culture, twenty-four hours old or older, first employed should be relatively large, from 1 to 10 c.cm., according to the animal and the method of inoculation. If these amounts prove active, smaller quantities should be tried until the limit is reached.

Next, the action of cultures from which the bacteria have been removed by filtration through porcelain should be tested, and if these prove active the effect of different degrees of heat on the toxicity of the cultures should be determined.

If by the experiments already mentioned a toxicogenic germ has been discovered, its morphological, cultural, tinctorial, and pathogenic properties may be studied as thoroughly as the investigator may desire. The study of the bacterial poison may also be carried to the same extent.

Meat-poisoning (Kreatoxismus).

Animals infected with pathogenic micro-organisms furnish meat that is not safe food for man. This is true not only when the animal is in-

fected with some grave disease, such as tuberculosis or anthrax, but also when it suffers from some disorder ordinarily considered as of but little importance. A severe diarrhœa in the animal may render its meat a highly harmful food. An instance of this kind has been reported by Gärtner: A cow, after showing for two days a severe diarrhœa, was killed and her flesh sold for food: 12 persons ate this meat raw, and all of them were affected. Of those who ate the cooked meat many also were ill. In the meat and in the spleen of a person who died from the effects of the poison Gärtner found a germ to which he applied the name *bacillus enteritidis*, and which is pathogenic to mice, rabbits, and guinea-pigs. Even boiled cultures are poisonous, thus showing that the bacterium elaborates a chemical poison which is not destroyed at the temperature ordinarily employed in the cooking of meat. The period that elapsed between the taking of the food and the appearance of the symptoms varied from two to thirty hours. The effects were those of a gastro-intestinal irritant, followed in some instances by desquamation of the skin.

Fischer reports a similar case: The cow, after a diarrhœa of eight days' duration, was killed, and on the second day after the killing 19 persons partook of the meat. All were soon vomiting and purging violently. Recovery was slow and was accompanied by exfoliation of the epidermis. Gärtner's bacillus was found in this meat also.

Septic pneumonia may follow the eating of diseased meat, as has been observed by Ballard, who attributes an epidemic in which there were 490 deaths to this cause.

Basenau obtained the germ, which he designates as bacillus bovis morbificans, from the flesh of a cow that had been sick for some days, probably of puerperal fever. This bacillus is pathogenic to mice, rats, guinea-pigs, rabbits, and calves. If a cow be inoculated with it, the germ will not only be distributed through the blood, but it may pass into the milk.

Zörkendorfer reports the presence of the anthrax bacillus in meat that poisoned many people, some fatally, near Töplitz in 1894. However, his identification of the bacillus cannot be regarded as positive. Anthrax was not known to be present at the time among the animals in that neighborhood. One of the hogs that furnished a portion of the harmful meat was known to be sick when slaughtered, but the nature of the disease was not known. This, together with the fact that the bacillus found in the meat and in the tissues of the fatal cases did not correspond with the typical anthrax bacillus, renders the conclusion drawn by this investigator of doubtful value.

It is stated on the authority of Di Mattei that the flesh of animals dead of symptomatic anthrax may retain its power of infection, having been preserved in a dry condition, for ten years.

The question of the transmission of tuberculosis through the flesh of a diseased animal to man is one about which there has been much discussion. Many experiments have also been made, and these have led to contradictory results. There are those who hold that it is sufficient to condemn the diseased part of a tuberculous cow, and that the remainder may be eaten with safety, while there are others who believe that tuberculosis is a disease *totius substantiæ*, and that "total seizure"

by the health authorities is imperative. To any one who has seen tuberculous cattle slaughtered these differences in opinion and in experimental results are easily understood. In the first place, the tubercular lesion may not be larger than a hazelnut, and may consist of a small gland which has been invaded, while, on the other hand, the diseased process may be widely disseminated. Again, the tubercles may be located only in the portions ordinarily discarded, and here they may consist solely of hard lumps which will not break down and contaminate other tissue in the process of removal. On the other hand, I have seen a tubercular abscess in the liver, holding nearly a pint of broken-down infected matter, ruptured or cut in removing this organ, and its contents spread over the greater part of the carcass. These facts easily show why one investigator succeeds in inducing tuberculosis in guinea-pigs by introducing small bits of tissue from a tuberculous cow into the abdominal cavity, while another equally skilful bacteriologist follows the same details and secures only negative results. No one cares to eat any part of the carcass of a tuberculous animal, and in this country, at least, the scarcity and price of meat are not so great that any one should consume such food. The writer is therefore most heartily in favor of "total seizure" and condemnation of every part of tuberculous animals. There are some who claim that a large proportion of the cases of tuberculosis in man originate in the consumption of the milk and meat of tuberculous animals. This assertion is wild and absurd. It rests upon no scientific basis, and is, in fact, positively contradicted by the fact that in adults tuberculosis usually begins in the respiratory organs or the adjacent glands, and that the germ is commonly introduced with the inhaled air. In children primary tuberculosis of the mesenteric glands is very common, and there can be no doubt that in these the avenue of infection is through the intestines. Moreover, the occurrence of mesenteric tuberculosis corresponds with the age when the child relies most largely upon cow's milk for its food.

We now turn from a discussion of the consumption of the flesh of diseased animals to a consideration of the effects of meats infected with harmful saprophytic micro-organisms. Instances of mass-poisoning from this cause are very numerous. This form of poisoning may occur from the eating of the flesh of any animal or from that from any part of the animal.

Sausage-poisoning, known as botulismus and allantiasis, has been long known, especially in Germany. Many of these cases have occurred in Würtemberg and the immediately adjoining portions of Baden. This fact has been ascribed to the methods there practised of preparing and curing the sausage. It was formerly common for the peasants of these districts to use the blood of the sheep, ox, and goat in the preparation of this article of diet. The blood was kept sometimes for days in wooden boxes at the temperature of the living rooms. Processes of putrefaction often began in the blood thus kept. This material, with chopped meat, was placed in the stomachs of hogs, which were then hung in the huge chimneys to be cured. At night the fire would often go out, and the mass would partially freeze and be thawed out the next day. The alternate freezing and thawing hastened decomposition, and the interior of these great sausages, called "Blunzen," would often be poisonous.

German writers have stated that when a poisonous sausage is cut, the putrid portion has a dirty, grayish-green color and a soft, smeary consistency. A disagreeable odor, similar to that of old cheese, is sometimes perceptible. The taste is unpleasant, and a smarting of the mucous membrane of the mouth, accompanied by constriction of the throat, follows.

The SYMPTOMS of sausage-poisoning present quite a diversity. The first effects may manifest themselves at any time from one to twenty-four hours after eating this food, and cases are reported in which it is stated no symptoms appeared until several days had elapsed. However, we must remember that trichinosis was in former times occasionally classed as sausage-poisoning, and it is highly probable that these cases of long delay in the appearance of the symptoms were really not due to putrefactive processes, but to the presence of parasites in the meat.

As a rule, there are first dryness in the mouth, constriction of the throat, nausea, vomiting, purging, vertigo, dilatation of the pupils, and a sense of suffocation. Marked nervous prostration and muscular debility follow. The pulse becomes thready, and cyanosis may be well developed. Commonly, the functions of the brain are unimpaired, but in some cases there may be active delirium, followed by coma and death. In the most dangerous cases there may be obstinate constipation.

The mortality differs greatly. In 1820, Kerner collected reports of 76 cases, of which 37 were fatal. In his next publication (1822) he increased the number to 155 cases, with 84 fatal results.

Post-morten examination after sausage-poisoning shows no constant or characteristic lesion. It has been stated that putrefaction sets in tardily, but Müller has shown that no reliance can be placed on this point, and he states that out of 48 recorded autopsies it was noted that in 11 putrefaction rapidly developed. Hyperæmia of the mucous membrane of the stomach and intestinal canal has been observed. Occasionally there are hemorrhagic spots found in these localities. The liver and other abdominal organs, as well as the brain, have been found congested, but this would result from failure of the heart, and would by no means be characteristic of poisoning with sausage.

Various theories have been advanced concerning the nature of the active principle of poisonous sausage. It was once believed that the ill effects were due to pyroligneous acid, which was supposed to be absorbed from the smoke used in curing ; but it was later observed that unsmoked sausage also might be poisonous. Hydrocyanic and picric acids have been suggested, but how these could possibly find their way into the sausage was more than any one could surmise. The suggestion of these substances seems to have been due to wild guesses, since the symptoms of sausage-poisoning have only the most distant resemblance to those induced by these agents. Then the active principle was believed to be a fatty acid, and Büchner proposed that it be called acidum botulinicum, but this has no existence, and the fatty acids actually present in poisonous sausage are devoid of toxic properties. Attempts to isolate the active agent by Brieger's method for the separation of ptomaïnes have failed. We can only say that the poisons vary according to the germs elaborating

them, and that they belong to that class of chemically indistinct bodies now known as bacterial toxins.

Instances of poisoning have been reported from eating ribs of beef, pork, brawn, ham, veal pie, tongue, dried beef, and fowl. As already stated, any meat when infected with toxicogenic germs may induce untoward effects.

The TREATMENT of meat-poisoning should consist in aiding the removal of the harmful substance from the body, washing out the intestines, the administration of intestinal disinfectants, and the maintenance of the action of the heart.

MILK-POISONING (GALACTOTOXISMUS).

I use the term *galactotoxismus* (milk-poisoning) to indicate the ill effects that result from the drinking of milk infected with saprophytic toxicogenic micro-organisms. This excludes all questions concerning the distribution of specific infectious disease, such as typhoid fever, Asiatic cholera, etc., through milk as a carrier of the infection. It also excludes the discussion of the transmission of infectious diseases, such as tuberculosis, puerperal septicæmia, etc., from animals to man by the use of the milk of the former as a food by the latter.

The studies of the past fifteen years have demonstrated that milk-poisoning is one of the most fruitful causes of a high death rate. A little more than one-fourth of the children born to the civilized world die before they reach five years of age, and about one half of these deaths are due to the so-called summer diarrhœas. The medical profession sought for the causative factors of these diarrhœas for many years in almost every conceivable condition surrounding the life of the infant. Inherited tendencies were considered, and, although these are important factors in the causation of the high death rate of infancy, they are of but slight weight so far as the summer diarrhœas are concerned. That the sins of the father, and of the mother also, are visited upon the child, often with apparently relentless cruelty, is a matter of every day's professional observation, but the child of the saint as well as that of the sinner cannot withstand the powerful poisons that may be generated in milk by bacterial life. Long and earnestly did the medical profession study the influence of meteorological conditions upon these diarrhœas. The temperature of the air and the soil, the humidity, the proportion of sunshine and cloud, the amount of rainfall, the direction and velocity of the wind, all were studied. Finally, the following conclusions became evident :

(1) These diarrhœas are practically confined to the hot months ;

(2) Only those who are artificially fed have these diarrhœas ;

(3) Since artificial feeding is substantially confined to the employment of cow's milk, this food must become harmful during the hot months.

Upon these well-observed facts there followed the discovery of most powerful poisons in milk infected with certain bacteria and kept at a temperature high enough for their development. Then followed a search for the specific bacterium of the summer diarrhœas, but no specific micro-organism for this disease has been found, and none will be found, be-

cause any one of a number of saprophytic bacteria is capable of elaborating a galactotoxicon (milk-poison). I do not mean to say that two species of bacteria will produce in milk identically the same chemical changes, but they will elaborate poisons which, so far as their effects upon children are concerned, are practically identical. The time may come when the chemist will be able to isolate these poisons, and when this has been done it may be possible by a study of the toxicological action of each of them to distinguish one from the other by observation of the symptoms. At present, however, this is impossible, and we must study these bacterial poisons as a group of gastro-intestinal irritants.

The fact that these harmful micro-organisms require a temperature of about 80° F. for their rapid growth and spread explains the reason for the limitation of these diarrhœas to the hot months of summer. Besides, since the bacteria are saprophytic, growing abundantly, as many of them do, on all kinds of decomposing vegetable and animal tissue, they are widely distributed in summer, and the chances of milk becoming contaminated with them is greatly increased.

It is not within the limits of this paper, as fixed by the editors, to discuss the summer diarrhœas of infancy in detail, and it only remains for me to describe milk-poisoning as it occasionally occurs in adults.

I once saw 4 cases of acute milk-poisoning in adults : 3 of them terminated fatally, and in 1 a post-mortem examination was made. The first symptoms were nausea and vomiting, and usually the effects of milk that has become poisonous from the development in it of toxicogenic bacteria is limited to these symptoms. But the poison generated in the milk taken by these people must have been of unusual virulence or present in great quantity. Unfortunately, in these cases there was no purging, and, the vomiting soon ceasing, the poison was retained. The tongue was covered with a heavy white coating. The pupils were dilated. The breathing was labored and rapid, being 35 per minute in one case. The pulse was weak and rapid, running at 120 or higher. The temperature was below the normal. The abdominal aorta throbbed most violently. The abdomen was retracted. The face was flushed, and the sufferers fell into a stupor from which they could at first be aroused with difficulty, but which deepened into coma, and, as has been stated, terminated in 3 out of 4 fatally.

The most striking feature found on section was the constriction of the circular fibres of the cæcum, ascending, transverse, and descending colon. These constrictions were observed at irregular intervals of a few inches, and were so tight that they completely closed the lumen of the intestine. This probably accounted for the obstinate constipation that formed a serious obstacle to the treatment. I had seen similar constrictions in the fibres of the intestines in animals experimentally poisoned with tyrotoxicon. With this exception I had seen nothing similar to this except in lead-poisoning.

Ordinarily, milk-poisoning, as it is observed in adults, does not require any energetic medicinal treatment. The vomiting and purging are sufficient to rid the body of the harmful ingesta. However, when Nature's attempts at elimination are insufficient no time should be lost in giving aid by the use of the stomach tube and the rectal douche.

Cheese-poisoning (Tyrotoxismus).

Under this heading may be discussed the untoward effects that follow the eating of cheese in which toxicogenic bacteria have elaborated their products. In order to avoid repetition we may also include the like effects resulting from the eating of other milk-products, such as ice cream, custard, cream puffs, etc., similarly contaminated with harmful bacteria.

In 1883–84 nearly 300 cases of cheese-poisoning were reported to the Michigan State Board of Health. The symptoms generally appeared within from two to four hours after eating the cheese. In a few the symptoms were delayed from eight to ten hours, and were then very slight. The severity of the symptoms varied with the quantity of cheese eaten. At first there was dryness, followed by constriction of the throat, then nausea, vomiting, and diarrhœa. The vomited matter at first consisted of the food eaten, then it became watery and was tinged with blood. The stools were at first semi-solid, then watery. The tongue was soon coated. The pulse became irregular and weak and the face pale and cyanotic. In some the vomiting and diarrhœa were followed by marked nervous prostration. Dilatation of the pupils was observed in some, not in all. In 1896, I saw cases of cheese-poisoning in which all who ate of the cheese suffered from prolonged vomiting and violent purging. Later a wild delirium set in. The pulse became imperceptible at the wrist, and the condition of the heart awakened the greatest anxiety and led to the hypodermic administration of stimulants. In another outbreak involving more than 30 people 2 were found in a comatose condition. These had neither vomited nor purged. The bowels were irrigated thoroughly and stimulants given hypodermically. All recovered.

In 1884 the writer obtained from poisonous cheese a basic substance which induced in animals the same symptoms observed in the persons who had eaten the poisonous cheese. This substance (tyrotoxicon) is, however, not the only active agent that may be present. The writer has examined many samples of poisonous cheese in which tyrotoxicon could not be detected. So-called toxalbumins may be present and may be accountable for the ill effects. These are present in the aqueous extracts of poisonous cheese, and may be precipitated from this solution on the addition of absolute alcohol. In 1896, Perkins and the writer obtained from milk cultures of a toxicogenic bacillus found in both poisonous cheese and ice cream a substance which was soluble in alcohol, and which proved fatal to rats, mice, and guinea-pigs. We were unable to obtain this body in a chemically pure state, and consequently we remain ignorant of its chemical composition. However, we know that it was not tyrotoxicon, and its ready solubility in strong alcohol removes it from the class of toxalbumins.

Ordinarily, in cheese-poisoning the vomiting and purging free the body of the harmful substance so completely that special treatment is not necessary. The most serious cases are those in which the vomiting is slight and the purging absent. In these prompt and efficient treatment is desirable. The stomach and intestines should be thoroughly washed. In all cases the heart's action must be closely observed, and the prompt

hypodermic injection of strychnine, aromatic spirits of ammonia, or brandy should be resorted to when the evidence of the need of such stimulation becomes apparent.

Fish-poisoning (Icthyotoxismus).

Some fish are armed with barbs connected with poison glands, and by means of these they protect themselves from their enemies. The flesh of these fish is not harmful. Bottard has described five forms of poison glands in fish :

(1) *Synancia brachia* may be taken as a type of one of these classes. In this animal there are thirteen barbs, each of which connects with two poison-reservoirs, and each reservoir is supplied by two tubular glands. The contents of these reservoirs consist of a bluish feebly acid fluid, which when injected undiluted into an animal causes local gangrene and, when diluted, local paralysis. The intensity of the poison varies in different species of the Synancidæ, the most poisonous being those that live in tropical seas.

(2) *Trachinus draco* (dragon weaver) is a handsome fish marked with blue and brown striæ. Dunbar-Brunton describes its poison apparatus as follows : " Upon each of its gill covers there is situated the spine in connection with the special gland. This spine is grooved and slightly erectile, and is attached partly to the maxilla and partly to the under suface of the gill cover. It passes through the gill cover, where it shows a sharp point, the length varying with the size of the fish. The spine is covered with a very fine membrane almost to its free extremity, and this membrane converts the grooves on the spine into little canals which open near the extremity of the spine. At the base of this spine upon the upper surface lies the poison gland, under the gill cover and partly covered by the adductor muscle of the gill cover, which helps to compress the gland, forcing the fluid into the canals, and at the same time erecting the spine When the spine enters another fish or other animal, its membrane is stripped back and the poison enters at once into the wound. The gland is small, with nucleated colorless cells, secreting a transparent fluid." If a guinea-pig be pierced in the thigh with the barbs of a trachinus, it cries immediately with pain. The limb twitches ; convulsive movements extend over the body, and these are intensified by touching the animal, especially on touching the wounded limb. Paralysis of the posterior extremities results. Urine and fæces are passed involuntarily. Respiration becomes difficult. Collapse and death follow, sometimes within one hour after the infliction of the wound. On the other hand, if the animal recovers the hair about the wound falls out and local gangrene takes place. Men sometimes wound their feet, while bathing, on the barb of the fish, which lies partly buried in the sand, or fishermen incautiously prick themselves with the barb. In these, stab-like pains appear in the wound within a few minutes. These pains pass over the entire body, and become especially severe over the heart. There is a sensation of suffocation ; the forehead is bathed in perspiration, while pain and fright combine and manifest themselves in cries of anguish. The heart becomes weak and intermittent. Wild delirium and convulsions sometimes supervene, and

collapse and death follow. The above is a picture of the symptoms when the amount of the poison introduced is large. Ordinarily, however, the effect is not so serious, and local œdema, followed by gangrene and accompanied by more or less general pain, is observed.

The TREATMENT of wounds of this kind should be both local and general. A crucial incision should be made at the point of puncture and free hemorrhage encouraged; then the wound should be cauterized. Alcohol, ammonia, and strychnine, whichever is at hand, should be administered.

(3) In *thalassophryne*, a genus of Batrachidæ, there is a half-closed poison gland situated on the gill covering and another on the back. "The poison bags have no external muscular layer, and are situated immediately below the thick, loose skin which envelops the spines; the ejection of the poison, therefore, can only be effected by the pressure to which the poison bag is subjected the moment the spine enters another body."

(4) In *Muræna helena* there is on the roof of the mouth a wide pocket, the walls of which are lined with poisonous glands. This pocket furnishes a secretion which covers some of the teeth.

(5) *Scorpœna scropha*, called by the French fishermen "le diable" and by the Italians "lo scorfano," has open poison glands connected with the hollow barbs of the dorsal fins.

In the above-mentioned fish the poison is the secretion of special glands, and, as has been stated, their flesh may be eaten without detriment.

We now turn to the discussion of fish that are poisonous at certain seasons of the year, and especially on account of the physiological activity of their reproductive organs. This is known to be true of different species of tetrodon (fugu) that inhabit Japanese waters. According to Remy, there are at least twelve species of this genus whose ovaries are poisonous. In winter, when the ovaries undergo physiological atrophy, the poison is present in smaller quantity than during the spawning season. However, the poison is never altogether wanting, and Remy's experiments were made with fish caught in the winter-time. He found that dogs fed upon the testicles or ovaries of these fish soon sicken, with salivation, severe and frequent vomiting, accompanied by convulsive muscular movements. On account of the vomiting the poison was soon removed from the body, and in order to prevent this the organs were rubbed up in a mortar and the fluid portion administered subcutaneously. When this was done the most constant symptoms were salivation, retching, vomiting, marked dyspnœa, cyanosis, dilatation of the pupils, relaxation of the sphincters, and partial paralysis. Death seemed to be due to dyspnœa. Post-mortem examination showed the salivary glands and pancreas ecchymosed, small hemorrhagic spots in the stomach and intestines, and the liver and kidneys filled with dark blood, as would be the case in death from asphyxiation. No lesions could be found in the brain or cord.

In men poisoned with these fish the most prominent symptoms are referable to disturbances of the nervous system, although vomiting may be severe and gastric hemorrhage may occur.

According to Miura and Takesaki, the ripe ovaries of *Tetrodon*

rubripes contain a substance that in rabbits accelerates the pulse and the respiratory movements, paralyzes the skeletal muscles, induces mydriasis, increases peristalsis of the intestines, and arrests the heart.

The disease known as "kakke," which prevails in Tokio from May to October, is believed by Miura and others to be an intoxication from the eating of fish belonging to the Scombridæ. This disease is generally chronic or subacute, seldom acute. Paralysis of the diaphragm, with consequent dyspnœa and disturbance of the action of the heart, seems to be the most characteristic effect. Electrical stimulation has proved to be the most successful treatment.

There are other fish whose flesh may be poisonous on account of the food upon which they feed; at least, the poisonous properties of their flesh are believed to be due to their food. These fish are most frequently met with in the West Indies, and it is to the symptoms induced by the eating of this food that the Spanish physicians have long applied the name *siguatera*. *Clupea thrissa* and *C. venenosa*, also certain species of *Scarus*, belong to this group. According to Günther, their harmful properties are due to the medusæ, corals, and other decomposing substances upon which they feed. In the West Indies, it is stated, all the fish caught off certain coral banks are poisonous. The symptoms are those of gastro-enteritis, and death frequently results. The treatment should consist of washing out the stomach and bowels and the administration of alcohol, ammonia, or strychnine.

The suggestion has been made that fish-poisoning may be due to substances employed sometimes to kill the fish. That this may have been true in some instances is possible, but that this explanation is not generally applicable is shown by the observation that where this method of obtaining fish for food is most frequently practised no ill results follow, and where it is not resorted to cases of fish-poisoning may be common. Cocculus indicus has been employed for the purpose of securing fish, and the leguminous plant *piscidia* of the West Indies owes its name to this use of its bark. In the Dutch East Indies the cortex of the root of *Derris elliptica* and the seed of *Pachyrrhimus angulatus* are employed for this purpose. Both of these contain a non-nitrogenous substance which is highly poisonous to fish and relatively harmless to other animals. An extract of derris root, which in Borneo is also used as an arrow poison, kills fish when mixed with water in the proportion of 1 : 25,000, and its active principle in a dilution of 1 : 5,000,000. Greshof has isolated both of these poisons and named them derrid and pachyrrhizid. A legumin, *Tephrosia ichthyonecea*, from West Africa, also yields a non-nitrogenous poison, but this affects other animals as well as fish. The fish-poison of Java, from the seed of *Milletia atropurpurea*, contains saponin, and that of Ceylon, from *Hydrocarpos inebrians*, owes its effects to hydrocyanic acid. *Robinia nicon* of tropical America is used by savage tribes for the purpose of benumbing fish. This plant contains a crystalline body which is said to kill fish when added to water in the proportion of 1 : 1,000,000.

Fish may be infected with some harmful micro-organism, and this or its chemical products, when transmitted to man in his food, may act harmfully. The most recent researches indicate that this is at least one of the causes of the alarming epidemics of fish-poisoning so frequently

known in Russia. Schmidt concludes his studies of fish-poisoning in Russia with the following statements:

(1) This poisoning is not due to putrefactive processes.

(2) Fish-poisoning in Russia is always due to some member of the sturgeon tribe.

(3) The ill effects are in no way due to the methods of catching the fish, the use of salt, or imperfections in the methods of preservation.

(4) The poisonous substance is not uniformly distributed through the animal, but is confined to certain parts.

(5) The poisonous portions cannot be distinguished from the non-poisonous either macroscopically or microscopically.

(6) When the fish is thoroughly cooked it loses its harmful properties.

(7) The poison is an animal alkaloid, produced most probably by bacteria that cause an infectious disease in the fish during life.

Arustamow has reported his studies on 11 cases of fish-poisoning, 5 of which resulted fatally. In the fish and in the liver, kidneys, and spleen of the poisoned persons he found a bacillus resembling, but not identical with, the typhoid bacillus. The most noteworthy symptoms were dryness of the mouth, mydriasis, vertigo, general weakness, and dyspnœa. The fish were eaten raw, and this author concludes that the ill effects were due to the bacteria.

In an outbreak of fish-poisoning in Russia the fish were taken from a pond in the water of which as many as thirty dead fish were found in the course of two days. Many other fish in the pond were evidently sick. From the dead and sick fish Sieber obtained, by anaërobic growth, a markedly toxicogenic bacterium to which she has given the name bacillus piscidus agilis. This is a highly motile germ, grows well on ordinary culture media, forms spores, and retains its virulence for months. It is not destroyed at a temperature of 65° C. It is pathogenic to fish, frogs, mice, rabbits, dogs, and guinea-pigs. Its filtered cultures are highly poisonous, and the same is true of distillates obtained from old cultures. It produces cadaverin and other known ptomaïnes and at least two unknown bases. Of one of the latter $3\frac{1}{2}$ milligrams suffice to kill a frog in fifteen minutes. The chief symptoms induced in the above-named animals by the injection of sterilized cultures are apathy, dyspnœa, and paralysis.

Anrep has found in poisonous Russian fish two basic substances. One of these is possessed of great toxicity, so that $\frac{1}{4}$ milligram of the hydrochloride produces noticeable effects in dogs, and $\frac{1}{2}$ milligram kills rabbits. The other is an oily body and less poisonous.

The "barben cholera" frequently observed in some parts of Germany is supposed to be due to eating sick barbels. The symptoms are similar to those of cholera nostras. The stomach and bowels should be washed out unless evacuation is sufficiently free, and stimulants should be administered. When the chief effect of fish-poison manifests itself in irritation of the stomach and intestines the disease is often designated as ichthyismus gastricus. When a scarlatinous rash accompanies the gastro-intestinal irritation the condition has been denominated ichthyismus exanthematicus. Both or either of these may result from eating either diseased or putrid fish.

The cases of fish-poisoning most frequently observed in this country are due to the infection of this food with saprophytic, toxicogenic bacteria. This most frequently occurs with canned fish. The writer has seen several cases of ichthyismus exanthematicus resulting from the eating of canned salmon. There were in these nausea, vomiting, purging, and marked prostration. A scarlatinous rash covered the trunk and limbs. The temperature rose to 102° F., and the respiration became shallow and irregular. The stomach and large intestines were thoroughly washed out, and 10 grains of calomel, soon followed by 12 ounces of solution of citrate of magnesia for the purpose of cleaning the small intestines, were administered. All the cases treated in this way recovered. One person, to whom opiates had been administered in order to arrest the purging and relieve the griping pain, died. The danger likely to result from suppressing Nature's attempts to eliminate the poison cannot be too greatly emphasized.

Dilatation of the pupils is frequently observed in poisoning with putrid fish. This is due to the action of a ptomaïne known as ptomatropine (cadaveric atropine), which may be removed from the aqueous extract of the fish by agitation with ether. However, this substance has never been obtained in a pure state, and we know nothing of its composition. We only know that the symptoms to which it gives origin are very similar to, if not identical with, those induced by atropine. It causes dryness and constriction of the throat, arrest of the secretion of saliva, dilatation of the pupil, ptosis, paralysis of accommodation, weak and rapid pulse, nervous excitement, possibly convulsions, and, with large doses, delirium passing into coma and terminating fatally. Section shows congestion of the brain, lungs, and kidneys, often hemorrhagic spots in the stomach and intestines, and cloudy swelling of the solitary follicles and of Peyer's patches. Schmidt states that 100 grams of putrid sturgeon yield 3 milligrams of ptomatropine, a quantity sufficient to kill two men.

Ergotismus.

Ergotismus includes all forms of intoxication with ergot.

Claviceps purpurea is a fungus that develops in the flowers of rye, other grains, and certain wild grasses. It is most frequently found in rye and darnel. The first evidence of its presence is the formation of a sweet, unpleasant smelling liquid in the interior of the flower. This fluid sometimes forms so abundantly that drops of it run down the stalk and fall to the ground. On account of the sugar that it contains, and which probably results from the decomposition of the flower, it attracts ants and other insects that aid in the distribution of the fungus. This sweet liquid is known as "the honey dew of rye." A mould consisting of filiform cells closely matted together now develops and forms the mycelium, which is designated as secale cornutum and which has long been known to be poisonous. A rainy spring, especially when followed by a hot, dry summer, is known to favor the growth of this fungus. With continuous and thorough cultivation of the soil this parasite disappears. As has been stated, ergot is more likely to develop on rye than on wheat, and for this reason ergotism is most prevalent in

countries where the people live largely on rye bread, and especially where the soil is inadequately cultivated. Epidemics of ergotism have in recent years been rarely observed, except in Russia and Spain. In the United States ergotism, as an epidemic, is unknown. However, there have been in this country sporadic cases due to the medicinal use of this drug or to its long-continued employment. As an abortifacient it has been much abused, especially by ignorant and criminal medical pretenders. The continued use of ergot is necessary in order to induce its most disastrous effects. After a few months ergot loses in toxicity, and for this reason epidemics of the disease follow harvests, and especially poor harvests, when the parasite is most abundant and the masses have to feed upon what they have without close inquiry into its quality.

Scarcely any other drug has been studied by so many chemists and with such diverse and contradictory results. Numerous attempts have been made to isolate the active principle or principles, but a preparation that has been heralded by one investigator as the possessor of all the virtues of the crude drug has been pronounced by another as devoid of all action. Space will not permit, nor would the interests of the reader justify, even mention of all the preparations that have been placed before the profession. Kobert and his student Grünfeld have found in ergot three poisonous bodies—ergotinic acid, sphacelinic acid, and cornutin—but as the first of these is not poisonous when taken by the stomach, only the others need be considered. In all cases of ergotism both the sphacelinic acid and the cornutin are taken in the ergot; therefore a clinical picture of the disease must be a composite resulting from the combining of the two, and varying with the preponderance of one or the other in the ergot taken. Jacobi claims that he has obtained from ergot a chemically pure substance having the formula $C_{21}H_{22}O_9$, and he believes this to be the active constituent of sphacelinic acid.

Sphacelinic acid is believed by Kobert to be the constituent of ergot that induces hyaline degeneration of the vascular walls, develops the cachexia, and causes gangrene. He therefore thinks that ergotismus gangrænosus is due to the predominant action of this principle. Grünfeld fed animals with sphacelinic acid. In cocks gangrene soon appeared in the comb, then in the wattles, tongue, wings, and crop. Hogs lost their ears from gangrene, they gradually falling off, a bit at a time. Horses and cows lost their tails, ears, and hoofs. In dogs and cats the gangrene usually began in the skin. Sphacelinic acid when locally applied in concentrated form caused gangrene of the tissues with which it came in contact. In this way it is easy to account for the necrosis of the epithelial tissue, the ulceration, and the hemorrhages in the intestines. If the dilution be so great that local gangrene does not occur, changes less in degree, but identical in character, are caused. In this way may occur the degeneration of the walls of the blood-vessels, which manifests itself in lessened elasticity and minute hemorrhagic extravasations, similar to those observed in poisoning with phosphorus.

On the other hand, cornutin acts more directly upon the nervous system, and is believed to be the more active agent in the causation of ergotismus convulsivus. Its action seems to be on the brain and cord,

affecting the vagus and vaso-motor centres and acting through the lumbar cord on the uterus.

Cornutin is an easily decomposable alkaloid and gradually loses its virulence. It is found only in fresh ergot, disappearing more quickly than the sphacelinic acid. From this it happens that those symptoms due to cornutin are more prominent in outbreaks occurring soon after the harvests, while those due to sphacelinic acid are seen in both early and late epidemics.

There are some who believe that there are ptomaïnes, or other fermentative products resulting from the action of ferments in the ergot on the albuminous constituents of the flour, that are responsible for the septic character of certain epidemics of ergotism. However, this is mere supposition, and there has been no scientific experimentation offered in its support.

Ergotismus acutus is characterized in its mildest forms by gastro-intestinal and vaso-motor symptoms. There are observed loss of appetite, salivation, nausea, vomiting, diarrhœa, colic pains, cyanosis, formication, muscular weakness, and feebleness of the heart's action. When larger quantities are taken there are dizziness, headache, mydriasis, failure of the heart, loss of consciousness or delirium, coma, and death. Abortion usually occurs when the sufferer is pregnant. When this occurs there is often free hemorrhage. From the acute form recovery or death results within a few days.

Chronic poisoning with ergot is best studied under the two forms (1) ergotismus convulsivus sive spasmodicus and (2) ergotismus gangrænosus.

(1) The convulsive form usually first manifests itself in symptoms similar to those of the milder forms of acute ergotism. After these have continued for some weeks the more markedly nervous symptoms appear. There are floating specks before the eyes, ringing in the ears, dizziness, formication, and irritation of the skin. The sight becomes dimmed, there is a tendency to somnolence, and the mental perception becomes less acute. Then there is pain in the back, followed by painful muscular contractions. An epileptical condition sets in and the usual hebetude results. The convulsive seizures sometimes continue for hours. In these spasms the flexors overcome the extensors. The hand is bent upon the wrist and the fingers are partially closed. Permanent contractions of this kind may be seen. Various groups of muscles may become involved in these contractions, and opisthotonos, emprosthotonos, and trismus may be observed. There may be spasm of the œsophagus and of the diaphragm, simulating hydrophobia. The tendon reflex is lost in a few weeks after the appearance of the initial symptoms. Later the symptoms resemble those of tabes dorsalis. There are pains in the legs, a girdle sensation, Romberg's symptom (increased inco-ordination of movement on putting the feet together and closing the eyes), and static and locomotor ataxia.

The psychical disturbances are often very marked. There may be stupor and acute dementia or melancholia. The condition resembles that of paralytic dementia.

In the first stages the pulse becomes threadlike and the extremities cold and the skin pale. The temperature falls below the normal.

There are chilly sensations and slight sweats. Exophthalmos in some becomes very marked. The hair falls out, the nails cease growing, and the epidermis upon various parts of the body may be raised in blisters. Nutrition necessarily is interfered with and a marasmic condition follows.

In ergotismus gangrænosus there are as initial symptoms pain in the back, formication, muscular contractions, chilly sensations, heaviness in the limbs, and a general sensation of weariness. An erysipelatous redness spreads over the toes and fingers and gangrene sets in. The gangrene is generally dry, and there is neither hemorrhage nor suppuration. One or more phalanges of the toes or fingers, the feet or the hands, the legs or the arms, may necrose and fall off. The external genitals are sometimes involved in these necrotic changes, and gangrenous patches may form on the skin of any part of the body or in the intestinal mucous membrane.

The DIAGNOSIS of ergotism is usually easy when it exists in epidemic form, but sporadic cases may greatly perplex the physician. The acute form is to be recognized largely by exclusion and the history, unless it be recognized by its effects on the uterus. Poisoning with phosphorus, arsenic, and antimony and with septic substances are to be excluded. The vomited matter might be examined for ergot, but this will not be of immediate value when the drug has been taken in soluble form.

The convulsive form must be distinguished from epilepsy, hydrophobia, tabes, and tetany. Usually the history of the case will enable one to differentiate these. The subnormal temperature will distinguish ergotism from the infectious diseases.

The gangrenous form is usually easily recognized. When ulceration of the intestines occurs and is followed by hemorrhage, there may be some difficulty in distinguishing ergotism from typhoid fever, but generally there is also gangrene of the extremities.

PROGNOSIS will depend upon the stage of the disease. As has been stated, recovery or death from the acute form occurs within a few days, and the prognosis must be estimated by the extent to which the heart is affected. In making this estimation the form in which the poison has been taken, and the amount, must be taken into consideration. In the convulsive form recovery may take place even after the seizures have become prominent. In the gangrenous type the extent of involvement is easily recognized, and will form the basis for a prediction of the result.

Section in fatal cases shows no constant characteristic lesions in the thoracic or abdominal viscera. The extensors of the limbs are usually atrophied. Microscopic examination shows a toxic polyneuritis which is classed by Leyden among those forms of neuritis produced by lead, mercury, arsenic, antimony, phosphorus, carbon disulphide, carbon monoxide, and alcohol. Tuczek found in 5 cases hyperplasia and fibrillar metamorphosis of the neuroglia at the expense of the nerve elements in the posterior columns of the gray matter. The alterations were found in the columns of Burdach, those of Goll being unaffected.

The prevention of epidemics of ergotism might be easy were it not for the ignorance and indolence of the people among whom such epidemics occur. A proper selection of seed and the thorough cultivation of the soil would soon eradicate the fungus. As early as 1858, Kühn

pointed out the benefit that would be secured by an early harvest of fields contaminated with ergot, since by this means the spread and subsequent development of this parasite would be checked. The fact that the ergot grain is much larger than the rye grain permits the easy separation of the two by means of sieves invented for the purpose. Moreover, the commercial value of ergot is so much greater than that of rye that the time given to the separation of the two would be profitably spent, and yet so dense is the ignorance and so pronounced is the indolence of certain peasant classes in Russia and Spain that epidemics of ergotism continue and probably will continue for many years.

The TREATMENT of acute ergotism should consist of washing out the stomach and large intestines, and the administration of calomel or castor oil for the purpose of cleansing the small intestines. Astringents, as tannic acid and bismuth subnitrate, possibly opiates also, may be indicated later.

In threatened abortion cold-water vaginal douches have proved to be of value. However, if abortion has already occurred, the uterus should be thoroughly cleaned out with all the attention to details given to abortion from other causes. In threatened coma or collapse alcohol, coffee, camphor, acetic ether, and strychnine, one or more according to the indications, may be employed with benefit.

In chronic ergotism the first thing to be done is to see that the patient is no longer supplied with ergoted bread. Indeed, it has been found that restriction to animal food for some days is wise. The stomach and bowels should be washed out. Calomel is the best intestinal antiseptic to start with, but later salol is more suitable. The chronic diarrhœa is to be treated by intestinal irrigation and the use of astringents and opiates. Amyl nitrite and nitroglycerin have been found to be of value in the convulsive form, while chloroform narcosis for the prolonged spasm has failed to be followed by good results. Chloral hydrate is recommended in preference to the bromides for the epileptic seizures. Paralysis of the extremities should be treated with massage and electricity. Galvanization of the spine for secondary changes in the cord has been found to be useless.

The first evidence of gangrene should be combated by attempts to dilate the bloodvessels of the affected part. At the same time the prevention of sepsis must not be overlooked. Local lukewarm antiseptic baths and mild mustard sinapisms are of value. Amyl nitrite has been recommended on the ground that it dilates the bloodvessels, but that it has such action in the extremities of more than momentary duration is doubtful. For its action on the heart strychnine is probably the most reliable medicinal agent, while proper nourishment and satisfactory sanitary surroundings are of still greater value.

Amputation should not be performed until the line of demarkation is well defined.

LATHYRISMUS.

Lathyrismus, or lathyrism, is a disease in the form of a spastic spinal paralysis, due to intoxication from the eating of the seeds of certain species of the genus *Lathyrus* of the vetch tribe. There are about 120 known species of lathyrus : 13 of these are native to the United

States, and others are cultivated here on account of their showy flowers. *Lathyrus odoratus*, the common sweet pea of the gardens, is an example of the latter. In the Mediterranean country, on both the African and European shores, lathyrism has been frequently observed. It is also known to occur in India and other parts of Asia. In Algiers it has been frequently observed in epidemic form, and some of the most valuable information concerning it has been obtained by French surgeons stationed in that country. The species whose poisonous properties have been best studied are *Lathyrus sativa*, German vetch; *Lathyrus cicera*, red vetch; and *Lathyrus clymenum*, Spanish vetch. It sometimes happens, especially in Italy and Algiers, that the grain fields are so filled with vetch or tares as to render the use of bread made from the mixture unsafe. In the same countries, as well as in others, the vetch is cultivated as a food for the lower animals, and in times of great scarcity the seed is mixed with wheat and rye.

Schuchardt has collected the literature of lathyrism, and I will refer those who desire a more complete history of the disease to his article. It seems that for many centuries it has been a custom in some parts of Europe to prepare a bread of vetch seeds or of these mixed with grains. As early as 1671 it was known that such bread seriously affected those who ate it for any length of time. In the above-mentioned year the grand duke of Würtemberg forbade the use of this food. This edict was repeated by his successor in 1705 and again in 1714. It was noticed at that time that those who ate this bread soon suffered from a marked stiffness of the legs. The disease was regarded as incurable, although death seldom or never resulted. It was said that hogs fattened on vetch lost the use of their limbs so completely that they could not walk. In 1691 a similar illness was reported in the grand duchy of Modena.

In 1784, Tozzetti reported an epidemic in Tuscany due to the fact that the people, on account of a scarcity of food, were compelled to nourish themselves on chickpeas. He states that the disease began in great weakness, especially in the lower extremities. Some lost the power of locomotion either in part or altogether. All in whom this paralysis was observed had eaten for three months or longer a bread made of two parts of chickpea and one part of rye or wheat. The peas used came from Tunis, and were white, grayish-white, greenish, or dark. Otherwise than in color they did not differ from the chickpeas native to Tuscany, save that they were smaller. Tozzetti planted some of them, and after their growth identified them as *Lathyrus sativa*.

In 1829 an epidemic in France due to eating of bread made of equal parts of chickpeas and grain was reported. The disease in this case was believed by Desparanches to be due to a lesion of the lumbar cord and its coverings. There were observed convulsive movements of the muscles of both the thighs and legs, and finally complete inability to walk.

In the same year a like epidemic was reported in India, where, on account of two successive harvest failures, the people were compelled to resort to the use of the vetch as food. In this instance some of the cases of paralysis were under observation for several years, and it was said that none of them recovered.

Since the above-mentioned year many local epidemics have been reported by English physicians in India. The claim has been made that lathyrism and beri-beri are identical, but this was conclusively denied by Irving as early as the seventh decade of the present century. This observer states that beri-beri is a disease from which the afflicted may recover either from the employment of medicinal agents or from change of climate, while in lathyrism there is no recovery from the well-developed paralysis. Furthermore, in the former disease the arms and the muscles of the chest are involved, while in the other the symptoms are confined to the lower extremities. In lathyrism there is neither contraction of the fingers nor a sensation of numbness in the affected muscles. Lathyrism does not cause death, while beri-beri does, and in the former the patient may remain in fair health with the exception of his inability to walk.

Several attempts have been made to isolate the active poisonous principle of lathyrus. Teilleux obtained a resinous substance which when administered to rabbits in grain doses caused tetanic movements of the muscles, and finally paralysis of the posterior extremities. Death occurred within four days. Bourlier obtained an alcohol-ether extract of the seeds of *Lathyrus cicera* which killed frogs and small birds within a few hours or within two days at most. An injection of two drops of this extract, diluted with five drops of water, into a sparling was followed by these symptoms: Immediately there was marked diarrhœa, accompanied by prolonged vomiting. The feathers became ruffled and the bird sat in a crouching position. The heart beat was accelerated. Respiration became difficult and rapid. The muscles of the legs became paralyzed, more markedly on the left side. Birds lived in this way from ten to twenty-four hours. In turtles this extract induced at first an excitement marked by unusual movements and accompanied by a profuse diarrhœa. Subsequently there seemed to be complete inability of movement, and this was followed by death. Marie obtained from the seeds of *Lathyrus sativa* an alkaloidal body, but when employed subcutaneously on guinea-pigs this substance failed to induce any of the characteristic symptoms of lathyrism. Astier obtained an aqueous alcoholic extract, keeping the temperature below 50° C. during the process of extraction. On the 10th of June, 1883, 2 decigrams of this extract were injected subcutaneously into a dog weighing 8½ kilograms. Ten minutes later there was a noticeable trembling of the posterior extremities, which ceased after half an hour. On the following day a second injection, containing 6 decigrams, was administered. This was followed by trembling in the posterior extremities and, later, paraplegia. On the 12th an injection of 8 decigrams was given. This was followed by convulsive movements, and after half an hour by complete paraplegia. Toward evening the posterior part of the dog was found to be completely paralyzed. From this condition the animal slowly but completely recovered. This experiment was repeated on three other dogs with the same results. Astier satisfied himself that the seeds used by him were free from any contamination and that they did not bear any mould.

The same investigator by employing the Stas method obtained from the seeds of *Lathyrus cicera* a volatile alkaloid body to which he gave

the name lathyrin. This body has a doughy consistency, is easily volatile, strongly alkaline, insoluble in water, slightly soluble in ether, but freely soluble in chloroform. It is soluble in dilute hydrochloric acid, and in this solution it gives many of the general alkaloidal reactions. On the evaporation of the hydrochloric-acid solution the residue is found to consist of needles, and these on being heated on platinum burn without residue. There is no record of physiological experimentation with this substance, and consequently there is no evidence that it constitutes the active agent.

There are those who claim that the seed of the lathyrus is harmful only when it is decomposed or when it is the bearer of some parasitic growth like ergot. There are others who believe that the poisonous symptoms are due to the mixture of these seeds with those of other plants, such as *Agrostemma githago* (corn cockle) and *Tolium temulentum* (darnel).

It seems quite evident that the poisonous principle, whatever it may be, is destroyed at a high temperature. The Arabs of Northern Africa eat vetch seed prepared in two ways. One of these dishes is known as kouskousou, and in this the seeds are steamed or boiled, while the other, known as galette, is cooked at a higher temperature; and it is said to be a well-authenticated fact that injurious effects more frequently follow the use of the former than of the latter.

That vetch seeds are poisonous to many of the lower animals has long been an observed fact, and has recently been demonstrated by direct experimentation. Gabery fed 18 ducks with vetch seed ground with corn. All the birds died on the first day with symptoms of intoxication, somnolence, and paralysis. Similar experiments with like results were made on geese and peacocks. Pigeons were found by this investigator to be immune. It is claimed by some that animals are not affected by eating the green plant, but this is denied by Ferraresi, who states that he saw 18 hogs paralyzed in their hind legs after feeding upon green vetch.

Verrier reports an interesting history of an attempt to feed horses upon vetch seed. In 1867, the price of oats being high in France, the proprietor of a line of omnibuses sought for some cheaper feed for his horses. Vetch seed was recommended on account of the high nutritive value as determined by chemical analysis. The trial was made on 45 horses, while the others, 150 in number, were kept on their accustomed food. At first 2 litres of the seed were mixed with 13 litres of oats, but as the mixture was not relished by the animals, the proportion of seed was reduced to 1 litre. This feeding was continued for some months. After little more than two months the horses began to show the effects of the poison. The most marked symptom was dyspnœa, which threatened asphyxia and necessitated tracheotomy. There was paralysis of the recurrent laryngeal nerve. The muscles of the larynx, especially the crico-arytenoideus posticus and lateralis, also the thyro-arytenoideus, were much atrophied. Microscopic experimentation showed the muscles to be without striation and undergoing fatty degeneration. More chronic poisoning caused paralysis of the posterior extremities and death.

Cantani has probably given the best clinical picture of this disease.

He believes that the characteristic lesion is in the muscular fibres, and that the intramuscular nerve branches are not affected. He cut a small bit of muscle from the leg in a well-developed case, and found on microscopical examination that the transverse striations were indistinct and the muscle was infiltrated with minute fat drops. However, Cantani is most likely in error in holding that the nerves remain unaffected.

The first SYMPTOM is often a chill, which is followed by pain in the loins and legs, a girdle sensation, and motor lameness of the lower extremities. The patient walks with difficulty, and later finds locomotion wholly impossible. The knee reflex is greatly intensified. There may be marked paræsthesia with formication. In some instances gangrene in the feet and legs has been observed. Incontinence and impotence are common and early symptoms. The old belief that recovery never occurs is not supported by recent observations. Certainly many of the milder cases are greatly improved by proper medical treatment.

The most important part of the TREATMENT of this disease must be prophylactic. When the disease is developed it is to be treated as a spastic spinal paralysis or myelitis due to other causes. The application of irritants, such as a mixture of tincture of iodine and croton oil or of the actual cautery, to the lumbar spine has been found to be of value. Warm baths, galvanization, and faradization have been recommended. Bromide of potassium in gram doses, repeated from three to six times per day, has been found to be of most value in anæsthetic cases. Strychnine and quinine are not only without value, but are apparently harmful.

MAIDISMUS (PELLAGRA).

This is a progressive disease leading to paralytic and other nervous disorders and due to intoxication from the eating of damaged maize. Pellagra was first observed in Spain, where it appeared in the neighborhood of Oviedo in the year 1735. Its geographical distribution is still confined to that portion of Europe lying between the parallels of 42° and 48° N. With the exception of Corfu, one of the Ionian Islands, pellagra has never been observed outside of the above-mentioned territory, and in this region it is by no means universally or evenly distributed, but it prevails in some localities to such an extent that it has become a national calamity. This is true in Northern Italy. In 1879, 100,000 cases were reported in Italy, and in 1881, 56,000 in Lombardy only. The latest reports indicate no abatement in the increase of the disease. Pellagra is confined to countries where the staple article of diet is maize, and yet that Indian corn constitutes a most nutritious and healthful article of food is abundantly demonstrated by the well-nourished condition of the large colored population of the Southern United States. There probably never has been a class of day laborers, certainly never a class of servants, better fed and nourished than were the negroes of the South before their emancipation, and that corn bread, made from the mature grain and properly prepared, is both healthful and nutritious has been abundantly demonstrated. Pellagra is known only in those countries where on account of an uncongenial climate or from barrenness of the soil maize does not mature. Possibly inadequate

cultivation is also, to some extent, responsible for the ill effects. One author states : "Although Lombardy is the garden of Italy, its peasants are over-worked, under-paid, and under-fed ; instead of a diet suited to their severe labor, their sustenance consists largely of the more worthless kinds of Indian corn of their own growing, the produce of poorly cultivated ground, sown late, harvested before maturity, and stored carelessly in its wet state ; even if they grow a certain proportion of good maize corn, the millers, to whom they are often in debt, are more likely to grind the worse samples for the peasants' own use. The flour is either made into a kind of porridge—the polenta of Italy, the cruchade of Gascony, or the mamaliga of Roumania—or it is made into loaves without yeast, baked hastily on the surface only or on one side, and raw and wet within, large enough to last a week, and apt to turn sour and mouldy before the week is out."

That pellagra is an intoxication due to poisons formed in corn meal or bread there can scarcely be a doubt. However, we have no positive information concerning either the ferment which causes these harmful changes or the poisonous substance or substances that are formed. Some think that the disease is an intestinal mycosis due to infection with a parasitic mould which is introduced into the body with the food. Cuboni has found in the damaged meal used by pellagrous persons, also in their fæces, a bacterium to which he has given the name bacillus maïdis, and to which he ascribes the disease. Majocchi claims to have found this germ in the blood of a pellagrous individual. According to Paltauf and Heider, the grains of corn become infected during the wet season with the bacillus maïdis and the bacillus mesentericus fuscus, and these bacilli decompose the moist meal, producing maize ptomaïnes, which are the active poisonous agents. Others claim that the so-called bacillus maïdis is nothing more than the widely distributed potato bacillus ; that it is incapable of elaborating poisonous products under any conditions ; and that it is by no means constantly found in the intestines of the afflicted.

Lombroso claims that certain chemical poisons are formed by bacterial activity in the food, and that the disease is truly an intoxication rather than an infection. This investigator has obtained from putrid corn which has been allowed to ferment at from 25° to 30° C. for from twenty-four to thirty-six hours an alcoholic extract and an oily substance, and with these he states that he had induced the characteristic symptoms of pellagra in man and in animals. The alcoholic extract contains a basic substance or substances to which Lombroso has applied the name pellagracein. His theory is that there are two different poisons, and that their combined action gives rise to the complex of symptoms of pellagra, similarly to the action of sphacelinic acid and cornutin in ergotism. One of these poisons has a strychnine-like effect, while the other is narcotic in its action. All of this needs confirmation and more elaborate study.

Neusser believes that there is nothing directly harmful in the food when it is taken into the body, but that poisons are formed from the constituents of the food in the intestines. In other words, he makes the disease a specific form of auto-intoxication.

Pellagra is more prevalent in years of scarcity than when food is

abundant. It is stated that sporadic cases are due to the use of whiskey made from damaged corn.

This is a chronic disease, often continuing through many years, with periods of marked exacerbation and of remission. The former are most frequently observed during the spring, and especially during unusually wet seasons.

It is customary to consider the COURSE of this disease as consisting of three stages more or less marked and distinct.

The first stage begins with disturbances of the digestive organs. The tongue is heavily coated, and later loses its epithelium. There is loss of appetite, as a rule, though in exceptional cases the desire for food may be inordinate. The stomach seems swollen and is painful. Usually there is diarrhœa, but obstinate constipation has been observed. Certain nervous symptoms accompany those referable to the digestive organs. There is pain in the head, neck, and back. Dizziness, muscular weakness, and unsteadiness of gait are observable. Numbness of the brain and tardiness of mental action are noted in many instances. In the majority of instances, not in all, there is a characteristic erythema, which is most marked on the unclothed parts of the body, as the hands and face, though it may be much more widely distributed. It is this affection of the skin that has given the disease the appellation of pellagra (from *pelle*, skin, and *agra*, rough). The tendon reflex is usually greatly exaggerated.

The second stage is characterized by the prominence of certain cerebro-spinal symptoms. The patient complains of chilly sensations, of formication, of ringing in the ears, and of vertigo. The muscular weakness is increased; tremor and convulsive twitching become frequent. Cramps and light spasms occur. The tendon reflex is more markedly exaggerated. Sensibility is often diminished, and the patient falls into a state of melancholy. There may be well-marked vaso-motor disturbances. The skin becomes very pale, or there is capillary congestion over certain areas, notably on the face. Local œdema may appear. The erythema becomes intensified each spring, and the skin becomes dry, shrivelled, inelastic, and dark brown. In some cases the skin becomes hard and scaly.

The third stage is especially characterized by marasmus. The subcutaneous deposits of fat wholly disappear. Locomotion is impossible. Incontinence is persistent, and an uncontrollable diarrhœa makes the bedridden patient an object of pity. Fortunately, after this stage has been reached the individual loses all resistance to the infectious diseases, and tuberculosis or septicæmia frequently closes the history. A considerable number of pellagrous individuals end their sufferings by suicide.

DIAGNOSIS is not difficult, notwithstanding the great variations in symptoms, because the disease practically always exists as an epidemic.

The post-mortem findings may be stated as follows: The body is greatly emaciated. The intestinal walls are very thin on account of the wasting of the muscular coats. Ulceration in the intestines is frequently observed. The ganglions, the cells of the liver and spleen, and the muscles of the heart are deeply pigmented. Atrophy seems to be most marked in those organs connected with the vagus nerve, the lungs,

heart, kidneys, spleen, and intestines. Although marked alterations from the normal are frequently found in the brain and cord, there seems to be no constant or characteristic lesion.

The TREATMENT of most importance is the prophylactic. As has already been stated, maize properly cultivated, harvested, and cooked is not only a safe but a valuable food, and the existence of such a disease as pellagra is not only a national calamity, but a national disgrace. If communities be so poor that they must live on decomposed food, the state should relieve their poverty; if they be so ignorant that they poison themselves, the state should instruct them. Other grains should be introduced in order that the food should not be largely confined to corn. Varieties of maize which are better suited to the soil and climate should be selected for seed. Intelligent men should supervise the harvesting, the storing, the grinding, and, if need be, the baking. The Spanish have given this disease its most appropriate name—"mal de la miseria."

It is needless to say that there is no medicinal specific for this disease. Many of the milder cases recover when placed under proper hygienic conditions and supplied with proper food. For the advanced stages there is no efficient remedy. Pellagra is usually treated symptomatically. For the intestinal disturbances calomel and bismuth subnitrate are favorite prescriptions. The opiates and preparations of tannic acid are employed to control diarrhœa. In initial paralysis and for gastralgia Lombroso prescribes arsenic in the form of Fowler's solution, beginning with 5 drops and gradually increasing to 30 at a dose. For the attacks of vertigo the same authority orders tinct. cocculi orientalis, 3 to 5 drops. Iron, quinine, strychnine, and electricity (in its various forms of application) are brought into use, and are possibly of service in the less advanced stages.

DISEASES OF THE PERITONEUM.

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By HOBART AMORY HARE, M. D.

ACUTE PERITONITIS.

Definition.—Peritonitis is a term applied to inflammation of that serous membrane, the peritoneum, which lines the abdominal cavity and covers in its reflections or folds the organs which this cavity contains.

Etiology.—The moment we begin a study of the etiological factors involved in the production of acute peritonitis we come face to face with the question as to whether this disease is ever idiopathic, or, more correctly speaking, whether we can have an inflammatory process involving this membrane which is not due to some infection, traumatism, or to the spread of inflammation from adjacent tissues. While the medical profession cannot exclude idiopathic peritonitis from the list of possibilities, it is gradually coming to the view that such a form of the disease is so rare as to be almost unknown to the careful practitioner, and even in those cases where no cause for the trouble can be recognized before death it is found in many instances at the post-mortem examination that ample exciting cause existed through disease of adjacent organs. The advances of modern surgery, bacteriology, and pathology are daily affording demonstrations of the fallaciousness of the view that true idiopathic peritonitis ever exists, and those who find an opportunity for supporting their belief in the idiopathic form by citing the occurrence of idiopathic pleurisy as a similar process in an analogous membrane are having their proofs dissipated and destroyed by the accumulating testimony that pleurisy is more frequently than we have thought due to external or adjacent causes. Nor is this view based only on recent studies, for as long ago as 1862, Habershon, at a time when our clinical methods were far inferior to those of to-day, found in an analysis of 501 autopsies after death from peritonitis that over 50 per cent. (261) resulted from some primary disease not involving the peritoneum; and we have the statisties of Kelynack, who found in the records of 2855 post-mortem examinations 124 cases of acute peritonitis. Of these 124 cases, 94 occurred in 597 "surgical cases," and only 30 occurred out of 2259 medical cases. In regard to sex, 84 were males and 40 females. As a matter of fact, this division of the report into surgical and medical cases is almost useless from our point of view, for the entire 124 cases of peritonitis had it as a secondary lesion to some other trouble.

It is not possible to-day to state positively that exposure to cold, strains, and rheumatism never directly cause peritonitis, but that they do is very doubtful. Peritonitis due to other causes—that is, arising as a consecutive or secondary disease—is, however, unfortunately common. In the female its most common cause is inflammation or infection of some part of the genito-urinary tract, or, again, perforation of the alimentary canal as the result of gastric or duodenal ulcer. In both sexes it arises very commonly from appendicitis, from traumatisms of such a character as to injure the organs surrounded by the peritoneum, or from diseases of an inflammatory or infectious nature arising in the abdominal viscera.

Inflammation of the peritoneum may therefore be due to extension of an inflammatory process from an organ already inflamed, or to infection by micro-organisms which may or may not be originally malignant.

When the attack has originated in the appendix vermiformis, a part of the bowel where the bacillus coli communis exists in health as a benign micro-organism, the disease may arise from escape of this germ into the peritoneal cavity by perforation of the appendix or by the migration of the organism through the wall of the gut where it is acutely inflamed by a local disorder. This bacillus is also frequently found in the peritoneum after perforation of the stomach or any part of the alimentary tract which is liable to rupture or perforation. Any condition which enables it to escape into the peritoneal cavity also enables it to produce inflammation of a serious character. Thus it may escape in severe fecal impaction, in intestinal strangulation, and in cancer of the bowel, and it is a well-known fact that death in intestinal obstruction is frequently due to the secondary peritonitis arising from the escape of infection through the gut wall. This bacillus is the micro-organism of all others which causes peritonitis of an acute form. If the peritonitis be due to rupture of an abscess in the liver or spleen or in any other abdominal organ, the infecting micro-organism is generally the streptococcus pyogenes, although equally commonly perhaps will be found in association with the streptococcus or by itself the staphylococcus citreus, aureus, or albus. Much more rarely is found the pneumococcus of Fränkel, which, even if present, is probably very infrequently the cause of the disease. In cases of septic peritonitis following labor the streptococcus of pus is the causative factor, as it is also in peritonitis following typhoid fever and erysipelas.

When an attack of peritonitis arises from the rupture of a pus tube which has not been inflamed through gonorrhœal infection, the micro-organisms produce, as a rule, a virulent form of the disease, both streptococci and staphylococci being present. On the other hand, if the purulent process in the Fallopian tube has been gonorrhœal in character, the peritonitis is more apt to be localized than diffused, and therefore less fatal, provided the diplococcus of Neisser is the only organism present. Indeed, Bumm believes that the escape of this germ into the peritoneum is not capable of causing inflammation of this membrane, as it only exerts its deleterious effects on mucous membranes.

When peritonitis follows trauma the inflammatory process is either secondary or depends upon infection through the entrance of germs into the abdominal cavity by means of the instrument which penetrates the

walls of the belly, or through the wall of the bowel, which has its resistance to the passage of germs weakened by the injury. In all probability trauma in itself rarely if ever causes peritonitis directly, since the peritoneum is slow to resent an injury not accompanied by infection, and often slow to resent infection not accompanied by insult. Much depends in all cases on the general susceptibility to infection of the individual and to the vital resistance of the peritoneum itself. Where the susceptibility is great and the resistance feeble death follows, and where the opposite conditions exist life is saved. As illustrative of what the peritoneum will stand we have not only the daily operations of surgeons, in which it is roughly handled, but the interesting experiments of Rinne, who has shown that the peritoneum will absorb large amounts of septic material if not subjected to insult, and those of Pawloski, in which non-pathogenic micro-organisms and sterile foreign bodies were introduced into the peritoneal cavity without evil result.

It is to be distinctly borne in mind, therefore, that the evil results following injury or disease in any of the abdominal organs, so far as peritonitis is concerned, depend absolutely on the form of the micro-organism present, and for this reason rupture or perforation of the urinary or gall-bladder, as the case may be, are not necessarily followed by acute inflammation unless the escaping contents of these cavities are infected. If they are, peritonitis ensues. This fact is emphasized by Courtois-Suffit, Robin, Albarran, Gosselin, and Duprè. The close connection between the exciting cause of acute peritonitis and the character of the infecting microbe is shown by the fact that Malvoz has gone so far as to suggest that bacteriological evidence may be of value in medico-legal cases in determining the question as to whether the death of a person be due to peritonitis, to injury, or to infection. Thus, if the bacillus coli commune be found, infection is from the gut; if the streptococcus of pus be present, the infection is from the uterus if sepsis of that organ is present.

Additional causes of acute peritonitis are general septicæmia, puerperal or otherwise, miliary tuberculosis, and rarely severe malarial disease, particularly if the spleen or liver is affected. Dysentery due to the amœba coli may produce peritonitis, either by infection through the ulcerations or by secondary involvement of the liver with amœbic abscess. There is also no doubt that acute and chronic nephritis, particularly when they have caused uræmia, may cause uræmic peritonitis. Fitz asserts that peritonitis has followed suppurative inguinal adenitis.

Pathological Anatomy.—The characteristic primary lesion in acute peritonitis is the development of hyperæmia of the membrane, with the formation of a more or less copious glairy exudate, which, if it is in any quantity, rapidly becomes organized and produces adhesions which bind the coils of intestine together, attaching them firmly to adjacent organs. The character of this exudation varies greatly with the severity of the inflammation and its provoking cause. While the plastic element is a practically constant factor in its make up, its general character may be purely plastic, serous, or purulent, and in very infectious cases sanious. The purely plastic variety occurs in localized areas as a rule, and follows any simple aseptic injury to the peritoneum, or exists as a successful effort of nature to prevent the

spread of disease. It occurs after all surgical operations in which the peritoneum is invaded, and consists in such cases in nothing more than the normal process of healing by agglutination of its opposing surfaces.

In those cases where the exudation is largely serous the disease is always due to septic infection by micro-organisms which may or may not be pus-producing in character. A purulent peritonitis is also very distinctly a septic peritonitis, but clinically and pathologically we are forced to recognize the fact that either through a difference in vital resistance or in virulence of infection the same classes of micro-organisms produce in one case what we call septic peritonitis and in the other the purulent form—inflammatory processes which not only differ in their exudates, but present different morbid processes, for the septic peritonitis is invariably widespread, involving the entire peritoneum, while the purulent form is often localized through the formation of a fibrino-plastic exudate which limits its spread. It is probable, however, that these differences are in degree, not in kind, for in those cases of septic peritonitis which live long enough the exudate, which would have appeared serous had an early autopsy been made, is distinctly purulent and often putrid, this difference in degree depending, as we have said, on the severity and variety of infection and the individual resistance. In this form we find not only a copious exudate which covers the viscera, but fluid in large amounts in the abdomen, in which float large flakes of coagulated fibrin.

Should death occur in the first twenty-four hours of septic peritonitis, as it often does, no well-marked changes are visible to the naked eye save a duskiness of the peritoneum and the presence of sanious blood-stained serum in the dependent parts of the abdominal cavity. If the disease is secondary to malignant disease in adjacent organs, the peritoneal fluid is particularly apt to be hemorrhagic or blood-stained.

In all forms of peritonitis the walls of the alimentary canal in the parts involved become friable and œdematous, while their peritoneal coat is readily torn off from the muscular layers.

Whatever may be the seat of original disturbance, the pathological process which results in the peritoneum may be divided into three varieties: It may be localized and plastic, general and sero-plastic, or serous, changing to purulent.

In the first of these the inflammatory process, although intense, may be limited to a very narrow area by the reason of the plastic exudate with which the peritoneum seeks to protect itself and the general system from infective invasion, and which forms adhesions and walls of lymph which may absolutely limit the spread of any pathological process. Thus in the case of the appendix this organ may be so imbedded in lymph as to be effectually encysted, or the neighboring folds of intestine so coated and agglutinated by this exudate that an artificial wall is placed in the way of any widespread lesion. This is the form designated by Mikulicz as "fibrino-plastic peritonitis." Or, again, in cases of abscess of the liver the pus eventually escapes through the intestine or belly-wall without entering the peritoneal cavity, because in advance of the time of rupture of the abscess the near-by tissues have become walled off by exuded lymph. Similar processes often save life in per-

forative ulcer of the stomach or intestine and in inflammation or perforation of the uterus and Fallopian tubes.

More rarely still we find what is called pyo-pneumothorax subphrenicus, produced by perforation of the transverse colon or stomach, with pus encysted between the liver and diaphragm. These abscesses contain air or gas, because it escapes through the perforation or develops from the decomposition of foreign material in the sac. Sometimes no air is found in them.

Curiously enough, this condition very frequently produces secondary pyo-thorax by bursting upward through the diaphragm, but is very rarely caused by pyo-thorax perforating the diaphragm. Of 170 cases of this form of localized suppurative peritonitis, over 50 per cent. resulted from gastric perforation complicating ulcer. Among the other causes which may produce this localized form of suppurative peritonitis may be mentioned rupture of the spleen, abscess of the liver, and perforated duodenal ulcer, although rupture of an hepatic abscess, if it produces peritonitis of any form, usually causes widespread fatal peritonitis.

Very rarely too we find suppurative peritonitis in the lesser peritoneum as the result of disease of the pancreas, such as abscess or fat necrosis. Particular attention has been called to such cases by Musser, Lloyd, and Whitton, while White, Mason, Lafavrell, and Bowditch have reported cases due to renal calculus and nephritic abscess.

Strümpell asserts that children sometimes have a localized peritonitis in the left groin which is purulent and usually opens into the rectum, and in which recovery occurs.

The changes associated with the severe forms of peritonitis have already been described, and those found in tubercular peritonitis and in tuberculosis of the peritoneum are discussed by Osler (Vol. I. p. 770).

Symptoms.—The symptomatology of acute peritonitis is very characteristic, differing in various cases only as the cause of the disease differs, and presenting in all cases certain definite manifestations. Of the fairly constant symptoms we have severe pain in the belly, excessive tenderness on palpation, constipation, generally some fever, which is rarely very high, nausea, often succeeded by vomiting, and an expression of anxiety about the face which is out of all proportion to the length of time which the disease has lasted and often to the general condition of the patient. The pain is often mistaken by the patient for the cramp-like pains of severe indigestion, but the excessive tenderness of the belly separates it from this condition. So great is this tenderness that the slightest touch causes a cry of pain, and the weight of the bedclothes is unbearable even if the covering be of the flimsiest character. Often the whole attention of the patient seems to be centred in protecting his belly-walls from contact with any surrounding object, and with this end in view he lies on the back with the knees drawn up and the shoulders slightly bent forward to relax the belly-walls, at the same time using his hands to support his coverings. On the approach of an attendant the patient manifests fear lest inadvertently the belly be touched, the bed jarred, or the floor shaken by a heavy tread. Thirst is rapidly developed and becomes a most distressing symptom, since its satisfaction with any kind of fluid commonly results in increased vom-

iting or fruitless retching, which causes excessive pain by its disturbance of the inflamed area. Often the vomiting is alternated by persistent singultus. The belly varies in its appearance and in its sensation on palpation. Early in the disease it is sometimes scaphoid or retracted. Later it is generally puffy and tympanitic on percussion. Whether scaphoid or convex, however, the muscular walls are found fixed, hard, and resistant to such an extent as to be board-like in character. At each side, well down in the flank, there will be found flatness due to the sinking of the liquid part of the exudate to the dependent parts of the belly cavity. The face is not only anxious in expression, but rapidly becomes pinched and peaked in appearance; the eyes appear sunken, the skin somewhat pale and livid, and the tongue dry, parched, and protruded with effort. The pulse is very rapid, running and small, but wiry and somewhat tense, although this sense of resistance is soon lost as the characteristic feebleness of the entire system asserts itself. The skin may be hot with fever or cool and clammy with collapse even when the rectal temperature is very distinctly pyretic; but even if the thermometer in the rectum fails to show febrile movement, the physician is still to be on his guard, since one of the more important points to be remembered in connection with acute peritonitis is that fever when present is one of the positive signs of the disease, but its absence is not to be considered a negative sign, since it often is absent in severe cases. The hands share also in the pinched appearance of the face. The bowels are generally obstinately confined, but, if enteritis is also present, may in the early stages be distinctly loose. This is also true in peritonitis due to dysentery, but the rapid spread of the disease to the visceral layer of the peritoneum speedily places the intestinal walls in a state of quiet from spasm or paralysis of their muscular fibres or from reflex inhibition of the peristalsis through the splanchnics. The respirations are nearly always quickened, probably because a purely costal type of breathing is necessary through fixation of the diaphragm by pain.

As the case progresses the patient speedily passes into collapse. The pulse, before readily felt, is lost at the wrist; the skin may become quite cold, particularly in the extremities, and somewhat cyanotic in hue. The face is so drawn that the nasal, malar, and other bony prominences seem about to pierce the skin, while the lips are dry, slightly open, and somewhat retracted from the teeth toward the gums. The mouth is dry and the teeth lustreless from sordes and lack of moisture, while the tongue, which from the first was somewhat dry and pointed, is now narrowed and hardened until it resembles a parrot's tongue, and is protruded with great slowness on repeated requests from the attendant. Even up to the very end there may be preservation of consciousness, which may be supplanted by mild delirium or partial stupor.

An important point to be remembered in regard to acute peritonitis is that the symptoms are nearly always grave from the beginning, impressing the careful physician with the belief that the pain in the belly is indicative of serious disease. In addition to the symptoms just detailed, we frequently find on percussion, if this is possible, that the tympany of the abdomen is not diffused over this cavity, but occurs in spots. This separation of the accumulated gases in the bowel depends on the formation of inflammatory adhesions which bind the distended intestines into

sacs, the walls of which speedily become paralyzed by the inflammatory process. More rarely limited areas of dulness on percussion are found under the anterior belly-wall, due to the encapsulation, in exudative adhesions, of some of the effusion which otherwise would sink to the flanks. The displacement of the abdominal and thoracic viscera varies with the distention of the bowels and the severity of the disease. If the intestine has been perforated, allowing of the escape of gas into the peritoneal cavity, the tympany is increased, and often the gas getting between the liver and lower ribs renders it almost impossible to demonstrate any liver dulness. Similar causes may extinguish splenic dulness, and the apex beat of the heart may be displaced as high as the fourth interspace. The absence of liver or splenic dulness is not, however, pathognomonic of perforative peritonitis. Retention of urine, partly due to paralysis of the bladder and partly due to loss of reflex control, is frequently seen and requires catheterization. Rarely priapism is present or pain is felt along the dorsum of the penis.

In the localized forms of peritonitis the severity of the symptoms varies to an extraordinary degree with the individual attacked. Where the difficulty has its origin in the appendix, pain and tenderness in the neighborhood of McBurney's point, along with increased resistance on palpation and thickening, give us almost pathognomonic symptoms to deal with; and if a history of this character precedes the general attack by hours, days, or weeks, it is not hard to find the original cause of the disorder. On the other hand, in very severe cases the disease process spreads with such rapidity and the evidences of its existence are so universally present that the point of origin, whether it be in the appendix or elsewhere, is blotted out symptomatically in the general attack. While early localized symptoms may point, therefore, to a particular spot as the focus of the disease, the absence of localized abnormality should not be considered as indicative of there being no infecting centre which is provocative of the disease. Should the peritoneal inflammation result from any of the causes named as provocative of subdiaphragmatic abscess, the symptoms vary with the cause itself. In perforation of the stomach or duodenum the onset is usually sudden and painful. The pain, being distinctly localized, may closely resemble that of acute intestinal obstruction. There is also apt to be some cough, but, aside from this, there may be no distinctive signs, save that on the formation of pus a chill followed by fever may be present. Should pus be coughed up, this evidences perforation of the diaphragm and of the bronchus.

A very important fact to be remembered in regard to the symptoms of peritonitis is that some cases do not present evidences of excessive pain or tenderness. This is very apt to be the case in the septic peritonitis which comes on during the puerperium.

Complications and Sequelæ.—The course of acute peritonitis of a diffuse type is so brief, because of the very rapid inflammatory process which is always present, that it is rarely characterized by complications. Indeed, it may be said that any complicating factors in the case arise not as results of the disease, but from the causes of it, as, for example, perforation of the gut, the extension of inflammation from neighboring organs, and the rupture of abscesses or the presence of appendicitis. The sequelæ of acute diffuse peritonitis are dependent

almost entirely upon the density, contractility, and situation of the adhesive exudate which is left after the storm has passed by, or upon the power of the system to cause the absorption of the pus if the exudation has been purulent. Quite a common result of the formation of these dense adhesions is strangulation of the bowel by the slipping of a knuckle of gut through an opening in a band or over a false ligament, or by the development of a twist of the bowel through interference with its peristaltic movement.

Thus, Martin and the writer in their Fiske Fund Prize Essay point out the fact that the most common cause of obstruction of the bowel after intussusception is strangulation by bands, these abnormal formations contributing 25 per cent. of the cases of obstruction according to some other authors, and 36 per cent. in their classified collection of cases. "Strangulation comes on most commonly between the twentieth and fiftieth years, and is in the great majority of cases due to the remains of a former peritonitis" (Martin and Hare). Treves tells us that hernia-like strangulation of the bowel may occur as the result of former peritonitis, the organized lymph being drawn out into bands by the movement of the intestinal wall. The band may have its origin by an attachment to the intestinal wall and its insertion on the wall of the gut, or both origin and insertion may be parietal or visceral. More rarely the bowel becomes strangulated by the formation of omental cords, which are apt to be attached near the internal inguinal ring on the left side, and which form knots around the bowel. Peritoneal adhesions between two appendices epiploicæ may cause obstruction. Very rarely the appendix becomes attached to the abdominal wall or the intestinal wall by its free end, and so forms a band which may cause strangulation.

Of the complications which arise, tympanites and obstinate vomiting are perhaps the most common. The first is due to paralysis of the bowel by means of which peristalsis is set aside, so that gas accumulates. The formation of gas is probably aided too by the disturbed innervation of the intestine, whereby fermentation ensues as the result of perverted glandular action.

The obstinate vomiting is largely a reflex disorder, the nervous mechanism involved being to a great extent connected with the pneumogastric nerves. Another complication of considerable frequency for which we should always be on the watch is retention of urine, due to an extension of the inflammation from the serous membrane covering the bladder to the muscular walls of this viscus. The pain and final collapse of the patient are such constant symptoms of an attack that they can hardly be termed complications, but the thirst is often a complicating symptom of imposing magnitude.

Another complication which is of considerable interest is the development of pulmonary disease, such as bronchitis, congestion, and even true pneumonia. The two first named are not at all uncommon, but the latter is not frequent, although it takes place often enough to indicate the existence of some connection between the two maladies. Thus Treves points out that in 100 cases of peritonitis in the London Hospital no less than 17 developed pneumonia or pleurisy after the peritonitis began.

Diagnosis.—The diagnosis of acute diffuse peritonitis is readily made, because the symptoms it presents are all characteristic and commonly grouped together in a picture which clearly represents the condition before us. The severe pain, the rigid belly, the nausea, febrile movement, and intense abdominal tenderness (which far surpasses the tenderness of any other condition occurring in the belly), the constipation which supplants the diarrhœa of severe enteric disturbance from indiscretions in diet, are all almost pathognomonic symptoms, while the running pulse, drawn skin, anxious expression of the face, and the attitude of the body as the patient lies in bed complete the clinical study. The conditions with which acute diffuse peritonitis may be confounded are therefore few. In typhoid fever, when the case comes under our care late in the course of the disease or without a clear history accompanying it, the tympanitic belly and abdominal tenderness, due in part to the distention and in part to the enteric condition, may mislead the careless into a diagnosis of peritonitis, particularly if, as is more frequent than is taught by the textbooks, constipation is present.

Finally, we are to remember that there are cases on record in which coma has come on in peritonitis, so that pain is masked, and the patient does not complain even on rough manipulation of the belly. Such a condition in ordinary acute diffuse peritonitis is rare.

The condition closely simulating peritonitis is obstruction of the bowel, which is, as already pointed out, not only a sequel of previous attacks in some cases, but speedily produces peritonitis, owing to the escape of germs through the injured coil of intestine because of its inflamed state. A diagnosis of peritonitis with obstruction may be impossible unless the symptoms of obstruction are shown by the history to have preceded the general abdominal condition.

Acute hemorrhagic pancreatitis may so closely resemble peritonitis that a differential diagnosis is absolutely impossible, and, while this disease is rare, it probably occurs more frequently than we suspect. Further than this, even a microscopic examination of the fluid in the peritoneum may mislead us, since the bacillus coli commune is frequently found in the belly in hemorrhagic pancreatitis.

An interesting illustration of how closely hysteria may simulate acute disease is found in hysterical peritonitis, a condition in which every symptom of the inflammatory process may be shown, even to fever and apparent collapse.

The pain of gall stone and renal colic is so characteristic and centred, as a rule, in the neighborhood of the areas involved in the passage of the stone that a diagnosis of peritonitis from these affections is not difficult.

In cases of pyo-pneumothorax subphrenicus the diagnosis may be almost impossible. There may be bulging in the subphrenic region, quite marked if the abscess is in the median line, less marked if under the ribs on the left side, and better marked if on the right side by reason of its displacing the liver. Because of the depth at which the purulent collection lies palpation may reveal nothing more than tenderness, but the percussion note varies according to whether gas has escaped into the cavity or has developed there by decomposition of food stuffs. The area of resonance may be very limited and tympanitic,

but the area of dulness usually extends from the edge of the floating ribs upward to the nipple and posteriorly up to the angle of the scapula. If the effusion is on the left side, it is in the great majority of cases the result of perforated gastric ulcer, and exists between the liver, spleen, stomach, and diaphragm, whereas if the perforation be duodenal or in the appendix, the effusion will generally be right-sided. Should the effusion be left-sided, Traube's semilunar space may be extinguished, and Scheuler asserts that friction sounds can be heard near the diaphragm, while Mason has shown that where there exists side by side pleural effusion and subphrenic abscess aspiration above gives serum and below the diaphragm pus. As pleurisy, pericarditis, empyema, and pneumonia often accompany this form of peritonitis, the diagnosis is sometimes impossible.

Prognosis.—The prognosis in every case of well-developed acute diffuse peritonitis is distinctly unfavorable unless the disease be purely idiopathic, when the outlook is brighter. An unfavorable prognosis, or at least a guarded one, is always to be given, even if the physician thinks the attack idiopathic, not only because widespread inflammation of this membrane is fraught with danger, but also because in the majority of cases which seem idiopathic a serious provoking cause which we cannot discover is really at the bottom of the attack. If the provoking cause has been determined, the gravity of the prognosis depends to some extent upon the lesion. Thus if there be intestinal perforation or strangulation, the prognosis will be hopeless or hopeful in proportion to the possibility of surgical interference and its results. The disease in any of its forms may end life in thirty-six to forty-eight hours in severe cases.

The prognosis of suppurative peritonitis due to perforation of the stomach or duodenum is exceedingly unfavorable, the mortality being about 80 per cent.—much higher than in localized peritonitis due to suppurative peritonitis resulting from appendical disease, when it is more completely encysted.

Treatment.—The treatment of acute diffuse peritonitis is by no means as satisfactory as we desire. In those cases where we can discern no exciting cause which can be removed or benefited by surgical interference our therapeutics to-day is identical with that which received its highest recommendation from Alonzo Clark; but let the physician take care in deciding upon the Clark treatment that he has exhausted every art in diagnosis in the endeavor to discover some definite remediable lesion.

The Alonzo Clark method consists in the administration of opium in such doses that the severity of the pain is reduced, the vomiting controlled, and the patient placed in a state of moderate comfort, comparatively speaking. The dose of opium is not fixed, but depends upon the needs of the individual case, and the fact is to be remembered that cases of acute peritonitis bear massive doses of opium very well. As illustrative of this, Alonzo Clark treated successfully a case of peritonitis which took, after several days of smaller doses, the following extraordinary amounts each day: 32 grains morphine, 258 grains of opium, 212 grains, 221 grains, 224 grains, 224 grains, 247 grains, 261 grains, 144 grains. This patient was not, so Clark states, an opium habitué.

If the vomiting is too persistent to allow us to use the opium by the mouth, we give it hypodermically or by suppository.

In addition to the amelioration of the symptoms which we strive for and have already noted, the respirations should be reduced by the opium to at least twelve a minute, but the doses must not be large enough to so benumb the patient's sensibility that the objective and subjective symptoms are masked. It is the excessive use of opium with the production of a condition of narcosis which has thrown the opium treatment into disrepute with surgeons, who when called in to decide as to an operation find the symptoms calling for operation so extinguished that they are forced to act without the use of their best judgment, or more commonly find that the case has progressed so far that operation is hopeless, or, again, that the physician has overlooked some symptom the presence of which would be of superlative value in determining treatment, and which is set aside by the opiate. We believe that in all cases of peritonitis the outlook for the patient will be better if at the first a surgeon be called in to study the case with the physician, even if both decide that no symptom calls for operative interference, for the double reason that the two opinions may by a happy balance give the sufferer every chance, and that the surgeon may grasp all the details of the case before any of them are set aside by opium. Further than this, the presence of the surgeon from day to day, not to operate, but to consult, will give the patient all the advantage of an immediate operation should opportunity therefor arise.

In addition to the use of opium, it is often wise to resort to the application of turpentine stupes or of mustard plasters to the belly-walls, but blistering is useless and unnecessarily painful. Sometimes a high rectal injection made with or without the long rectal tube will relieve tympanitis, particularly if the liquid injected contain a teaspoonful of turpentine and some milk of asafœtida. In cases of peritonitis where asthenia rapidly develops, particularly if septic symptoms are manifested, alcohol should be given with the opium in generous amounts, from eight ounces to two pints daily, and care should be taken that old brandy or whiskey or some dry wine of "high bouquet" should be administered, as it will often stay in the stomach when other stimulants are vomited.

In cases where vomiting is not a symptom it is permissible to give nourishment by the mouth, but in the great majority of cases this is not to be attempted, since the presence of food in the stomach often brings on gastric irritability, either reflexly or because the stomach, being unable to digest and absorb, allows the food to become sour and unfit for use in the economy. In any event, milk is an article of diet to be carefully avoided, since it rarely agrees with the patient and tends to the formation of great tympanites. It is very much better to give the stomach absolute rest in cases of peritonitis, even excluding water in any quantity. The nutrition of the patient must be maintained by rectal enemata for the first few days at least, and the best form in the writer's opinion is the use of the following: Pour a pint of milk into a clean bottle, and add to it the white and yelk of an egg which has been well beaten. Add to this a tablet of pancreatin and one of sodium bicarbonate, such as are prepared for peptonizing purposes by Parke,

Davis & Co., and place the bottle in warm water at a temperature of 100° F. Allow it to remain for half an hour, then place on ice, and inject two ounces of this, after carefully warming it, every three or four hours. To this injection may be added, if desired, several drachms of whiskey or brandy or any other medicament. Often five to ten drops of fluid extract of hyoscyamus given in this way will quiet the patient, relieve tenesmus and strangury, and support the vaso-motor system. The thirst is best relieved, not by sucking cracked ice, but by now and then moistening the lips and mouth with egg-water made by adding the white of a raw egg to six ounces of ice-water. In other cases very finely shaved ice with white of egg or brandy poured over it may be given with advantage. Or, again, glycerin and water in equal parts, flavored with lemon juice, may be used to allay thirst and moisten the mouth by dipping a linen rag in this mixture and then placing it in the mouth, where it may be sucked. Sometimes, where retching is very persistent and without result because of emptiness of the stomach, a draught of pure water, even if at once vomited, relieves the patient by stopping the straining of the retching movements. By far the best remedy for the vomiting is small doses of acetanilid one half to one grain in powder every half hour or hour for five or six doses, or a small tablet composed of acetanilid gr. 2, monobromated camphor gr. 1, and citrated caffeine gr. 1, may be given at three- or four-hour intervals. Sometimes, if the belly is not too tender, a thin mustard plaster over the epigastrium will give relief, or, again, a small ice bag, particularly if there is one spot which seems very tender. The suggestion that the stomach be washed out by the stomach pump, while good in theory, is rarely if ever possible or justified in practice.

The question as to whether local or general abstraction of blood is to be resorted to in peritonitis has been actively discussed, and we believe that the general trend of professional opinion is becoming more and more strongly set against it. While it is true that the earliest stages of the malady may indicate acute sthenic inflammation, the whole tendency of the disease is toward the development of the most profound asthenia, in which every vital tissue is called upon for the preservation of life, and the advantages of bleeding in the beginning, if any exist, are more than overcome by the subsequent disadvantages. Cold to the belly, if there be no tendency to collapse, is, however, a painless and useful means of affecting the inflammatory process favorably.

Having stated that the stomach must be kept absolutely empty if possible, it is hardly necessary to add that all medicines which may be needed should be given hypodermically or by the rectum. Small doses of morphine may be needed to relieve pain without masking symptoms, and strychnine, digitalis, and atropine should be used to avert collapse and act as general stimulants. Beyond this the treatment of acute diffuse peritonitis is entirely surgical. Even if the localizing symptoms of the primary ailment are very obscure, the abdomen ought to be opened to discover if possible the exciting cause, and even if this is not found, the abdominal cavity should be well flushed out by perfectly sterile normal salt solution (7 : 1000), which should be warmed to 103° F., but not more. After this the wound should not be entirely

closed, but be drained for a short time by means of a tube or by packing it with gauze.

There yet remains for discussion as to the treatment of acute diffuse peritonitis the important question as to the exact value of saline purgatives as abortive or curative agents. The writer has already expressed his views very forcibly in the editorial columns of the *Therapeutic Gazette* and in his work on *Practical Therapeutics*. These views are that it cannot be gainsaid that the results obtained by surgeons in the use of saline purgatives in the treatment of peritonitis have been startlingly brilliant; neither can any one deny that their methods may sometimes be employed in medicine as well as in surgery; but there are several points to be recalled by the advocates and opponents of this treatment which the writer thinks so seriously modify the views of each as, after all, to unite them in a bond of unanimity. No one denies that the surgeon does rightly when he uses salines to prevent peritonitis after an operation; but the knowledge of the condition of the patient after he has been operated upon by the surgeon, and that possessed by the physician when called to see a case of peritonitis, are radically different; for the surgeon has a right to believe that the intestinal canal is patulous and devoid of impactions and intussusceptions, while the latter knows not whether he has before him an inflammation of the peritoneum without intestinal involvement or inflammation dependent upon some abnormality in the primæ viæ. As a consequence, it is perfectly proper for surgeons to administer salines, which, to use their own words, not only deplete the abdominal bloodvessels, but also, by the increased peristaltic movements produced, prevent adhesions; while the physician in the case of peritonitis from perforation, impaction, or intussusception may do the patient an immense amount of harm by such a procedure long before it is possible to decide what the cause of the trouble may be. It is evident, therefore, that the opium treatment rather than the purgative treatment must be adhered to, at least until the cause of the disease is discovered, unless the physician believes that at the very first sign of peritonitis an exploratory incision is to be made. Before operating, however, it should not be forgotten that pain and tenderness, with other signs of inflammation, are the symptoms not only of peritonitis, but also of many other states in the ordinary individual.

It is also evident that other conditions may exist than those named which render the administration of purges unjustifiable, and in which the use of the knife by the surgeon is not to be thought of, as, for example, cases of profound collapse due to possible perforation or hemorrhage. It is undeniable that the surgeon should be summoned the moment a suspicion of threatened perforation arises, but in the case of a person in whom an enteritis and peritonitis have arisen locally by reason of an old adhesion, increased peristaltic movement by purgatives is equivalent to strapping the normal side of the chest in pleurisy with the object of giving the diseased side more exercise.

Again, it is of the gravest importance that both the physician and surgeon should distinguish very clearly between an inflammation of the peritoneum in a strong, healthy person and in one who is in a condition of vital depression or exhaustion from prolonged disease elsewhere. Depletion by means of purges is, in the first class, as much indicated as

the application of leeches or bleeding, but in the second class quite as strongly contraindicated. In the dynamic form of inflammation there is danger of adhesions being formed by reason of the fibrinous exudate thrown out; in the adynamic condition of inflammation there is already an exudation of serum into the abdominal cavity which purges cannot remove until they have drained off a large amount of liquid from the blood; and the primary result of their use is to deepen the feebleness which may already be the most pressing symptom manifest.

The subject of TREATMENT of suppurative or localized peritonitis from appendicitis does not fall to the lot of the writer (see p. 308). The treatment of subphrenic peritonitis due to perforation of the stomach is chiefly operative, and is therefore a surgical procedure. The proper thing to do is to open, irrigate, and drain it, and to close the perforation, but even if this is done the outlook is very bad. In 27 cases of perforated stomach collected by Gilford only 6 recovered, and the only case in which recovery followed an operation for subphrenic abscess from this cause is that of Ewart and Bennett reported in 1894, where recovery followed, although secondary empyema requiring aspiration developed.

A work having the scope of the present one does not include a consideration of the surgical treatment of peritonitis, whether diffuse or localized, yet the writer cannot avoid emphasizing his already expressed opinion that the surgeon should not only see these cases, but operate on most of them. The following report of a case in the writer's practice is of interest in this connection:

W. M——, aged nineteen, was taken ill March 5, 1895, at midnight. He was seen early the following morning, ten hours after the beginning of the attack, by my assistant at the Jefferson College, Dr. Thornton, who, thinking that the pain which he complained of in the lumbar region might be due to muscular rheumatism, gave him a Dover's powder of ten grains, which was repeated three times in the next four hours. Dr. Thornton was then taken ill, and at eight o'clock on the evening of the 6th I was sent for, and on arriving found his patient with a pulse of 150, temperature of 102° F., respiration 28, with a scaphoid, rigid belly-wall, not excessively tender, and an anxious, restless expression. Recognizing the probability of an acute peritonitis, but being unable by any external means to find any trouble with the appendix, a rectal examination was made, with the discovery of slight tenderness in the right iliac fossa.

I immediately sent for Dr. W. W. Keen, who on his arrival agreed with me that there was perhaps appendicitis, and certainly acute peritonitis, and that death would occur if the disease was allowed to run its course without surgical interference. We both urged immediate operation, which was performed, just twenty-four hours after the attack began, by Dr. J. Chalmers DaCosta. On opening the belly it was found that the entire peritoneum was in a condition of acute hyperæmia, lacking the characteristic lustre of health. Because of the uncertainty of the trouble being in the appendix, a median incision was made, and it was found that an intestinal obstruction existed by reason of a fibrous band, over which a knuckle of the ileum, near its attachment to the colon, had been twisted. It was also found that the appendix was

acutely inflamed; its lining mucous membrane was much thickened, and it lay curled upon itself in the shape of the letter S, the curls being closely bound together by exuded lymph. The appendix was removed, and the peritoneum flushed out with hot saline solution, and then closed with drainage, the operation lasting fifty-five minutes.

Notwithstanding the fact that the patient suffers from a loud aortic obstruction murmur due to early attacks of rheumatism, his circulatory condition on coming out of the ether was better than when the anæsthetic was first administered, and he passed the rest of the night in comparative comfort, sleeping most of the time, it being necessary to administer opiates for the relief of pain. He recovered.

This case is one which ten years ago would certainly have been diagnosed as a case of idiopathic peritonitis, since the most careful examination by Dr. Keen and myself failed to elicit any evidences of appendicitis, and there was an entire absence of any of the common symptoms of intestinal obstruction. The only suspicious symptom of appendicitis was the tenderness in the right iliac fossa, which might very readily have existed in the presence of an acute general peritonitis. The patient was so ill when we first saw him that death would almost certainly have come to him within twenty-four hours had operative interference not been resorted to. The case illustrates the importance of early operation and the discoveries which may be made by an abdominal incision in cases of obscure peritonitis—an incision which in all probability will reveal a provoking cause, and which does not, to the extent that some have supposed, increase the danger of the patient if no provoking cause can be found.

It is not necessary to quote at length from various sources as to the correctness of this statement. As instances, however, mention may be made of Lockwood's cases, in which the operation of opening the belly to discover the cause of the attack ended in the recovery of the patients. In one of these there was peritonitis of forty-eight hours' standing as a result of perforation of the ileum. In another a peritonitis which had existed fifty-two hours, having its origin in sepsis of the left Fallopian tube, recovered after cœliotomy. In a third recovery also occurred. On opening the belly, which was full of gas, the characteristic fluid and coagula were discovered. The gas was removed from each coil of distended gut by puncture with a fine trocar, and any imprisoned fæces were let out by an incision in the intestine which was afterward closed. After this irrigation and drainage were performed. Similarly, Marsh reports another instance in which in the face of acute general peritonitis he opened the belly, removed the intestinal contents by means of a cannula, and performed lavage of the peritoneal cavity. Recovery occurred. Herhold also reports two similar cases in which recovery took place. Surgical experience points emphatically to the fact that the best chances of good results from operative procedures are to be obtained in cases of localized peritonitis. After this the best chance is in general suppurative peritonitis, and least of all in septic peritonitis, in which medical as well as surgical treatment is practically of little or no avail. Thus out of 65 cases of pelvic (localized) peritonitis operated upon by Mayo Robinson there were only 2 deaths. Tubercular peritonitis offers the best results of surgical interference of course, but this does not fall

within the limits of this paper. The statistics of operative interference in all forms of peritonitis have a valuable addition in the results given us by Osmolovski, who has collected 154 cases, from general medical literature, of operative interference for this condition. The greater number occurred in the practice of German surgeons. Of the 154 cases, 68 died and 86 recovered, while in 2 cases Osmolovski does not know the result. These cases represented almost every form of peritonitis except the tubercular form, as pointed out by Mayo Robinson in the *Medical Annual.*

Again, Kreche has collected 119 cases of general peritonitis treated by operation. In 101 of these cases the cause was perforation—36 from perforation of the appendix, 12 cases of typhoid perforation, of whom 5 recovered; 12 others were due to perforation from gangrene or other bowel complications; 3 cases caused by punctured wound and 1 from gunshot recovered, but of 8 cases due to contusion only 3 recovered. Operation also saved 5 out of 13 cases of puerperal peritonitis. The remaining 9 cases were due to various causes, and gave 3 deaths and 6 recoveries, or a total of 51 recoveries and 68 deaths.

Finally, we must never forget that the favorable results following operative interference in peritonitis of an acute form are in direct proportion to the earliness of the operation.

CHRONIC PERITONITIS.

By far the most common form of chronic peritonitis is that which is called tubercular, a condition thoroughly considered by Osler in his article on Tuberculosis (Vol. I. pp. 770, 775). After this variety there still remain for consideration those less frequent forms in which, during the course of weeks or months, there is abdominal tenderness perhaps, but more commonly swelling of the abdomen, thickening of its walls, and the development of ascites, or, if fluid be present, palpation will discover deeply-seated indurated masses or nodules, partly due to peritoneal exudation and partly due to the binding down of lymph-enclosed coils of intestine. Sometimes the presence of chronic peritonitis is not suspected until the autopsy reveals it, the patient complaining of no abdominal distress, or suffering only from obstinate constipation, diarrhœa, or irregular bowel movements, due to the disordered peristalsis resulting from the slow inflammatory process present. Under the latter condition, however, it will generally be found that the chronic process is localized to some one portion of the abdominal cavity, just as we have similar localizations of acute peritonitis. So far as the morbid anatomy of these cases is concerned, it is found that the peritoneum locally or widely is thickened, covered with lymph in greater or less thickness, and that this exudate has caused contractions of the omentum till it is scarcely more than a shred as compared to its normal size, while the mesenteric contractions often have twisted the coils of intestines in various abnormal positions, in which they have been rendered more or less immobile by attachments to one another or to the anterior belly-

wall or omentum, or to the other abdominal organs. The fluid which is found in both the localized and diffuse variety of chronic peritonitis is often perfectly clear, but sometimes cloudy and rarely sero-purulent in character. It is nearly always very albuminous, readily coagulated, and so differing from the effusion often found in ordinary forms of ascites. Sometimes small flakes of fibrin may be found in it.

The ETIOLOGY of chronic peritonitis of the diffuse type is obscure if tubercular infection is eliminated. It has been thought that exposure to cold and the many causes of acute peritonitis acting upon an individual with sufficient resistance to forbid an acute inflammation might result in the chronic form, but in the majority of cases it would seem probable that the infection has been mild and constant, as, for example, that which follows prolonged subacute inflammations in the pelvic organs of women, from which there arises a peripheral irritation never sufficient to cause an acute peritonitis. Certainly this is the most common cause in cases of the localized forms. Sometimes a low-grade peritonitis follows repeated paracentesis abdominalis, either in the area of puncture or in the entire peritoneum. Sometimes what Friedreich calls chronic hemorrhagic peritonitis follows repeated tapping, the entire peritoneal surface seeming to be granular, reddened, and dotted with extravasations of blood.

In the DIAGNOSIS separating the tubercular form of peritonitis from the more rare variety the effusion on withdrawal should be carefully examined for evidences of tubercle, but the absence of the bacillus is not proof that the disease is not tubercular, for it is very difficult in many cases to discover the germ unless the wall of the cyst be examined also. Often in such cases the peritoneum will at the autopsy seem studded with tubercles, which are, in reality, not due to tubercular disease even if they closely resemble the lesions of that condition.

The PROGNOSIS in chronic peritonitis is quite favorable. The danger does not lie in the disease itself, so much as in the complications which may arise from strangulation of the bowel or pressure upon abdominal organs of importance.

Should fluid be present in chronic diffuse peritonitis, it should always be removed by paracentesis as rapidly as it forms.

CANCER OF THE PERITONEUM.

CANCER of the peritoneum as a primary lesion is exceedingly rare, though its secondary involvement from the abdominal organs is not very uncommon. One of the most interesting cases so far reported is that of Ferguson, reported to the New York Pathological Society, in which he removed an enormous colloid carcinoma of the peritoneum from a man of fifty-one years. Both the visceral and parietal layers were involved, as was also the omentum, while the mesentery was ten centimetres thick in parts. The tumor masses showed under the microscope a fibrous stroma containing large alveoli lined with epithelial cells undergoing colloid degeneration.

Among the other unusual diseases affecting the peritoneum we have hydatid cyst, which is found, of course, more commonly in the abdominal organs than in the peritoneal cavity itself. Jones has reported an orange-sized cyst in the mesocolon removed successfully by operation, while Rein records the case of a woman in the third month of pregnancy who had a hydatid cyst in the omentum. This cyst contained smaller cysts, as is so commonly the case, the maternal cyst being unilocular. Recovery was reached on the twentieth day after operation and pregnancy went to term. Similarly, Astashevski has reported a successful removal of hydatid cyst from the omentum. As death has followed exploratory puncture, it is best to remove the cyst entire if possible. The largest number of cases of hydatid disease of the peritoneum so far collected (32) are those of Monéger, in the *Gazette des Hôpitaux* for Dec. 29, 1892. He finds that such cysts are nearly always secondary to the rupture of cysts in the more common areas for their formation, and that they are often, if not always, multiple. Violent pain often comes on in paroxysms when the growth is in the omentum, and the diagnosis is almost impossible without exploratory operation. One of the most extraordinary records is that of MacDonald, who reports the case of a man of twenty-six who had thirty hydatid cysts of the peritoneum. Cœliotomy effected the emptying of the larger ones by aspiration, but all could not be touched. After flushing with carbolized water recovery occurred, and the man seemed well two years later. Cases with multiple cysts operated on, with partial or complete removal, have also been reported, notably by Sutton, who records a recovery almost as extraordinary as that reported by MacDonald.

Besides cancer of the peritoneum, we also find other tumors, such as sarcoma and cystic adenoma, which are nearly always secondary.

[Tuberculosis of the peritoneum is described in Vol. I. pp. 770–775.]

DISEASES OF THE LIVER AND GALL BLADDER.

DISEASES OF THE LIVER AND GALL BLADDER.

DISEASES OF THE LIVER.

By J. E. GRAHAM, M. D.

PHYSICAL DIAGNOSIS.

Two methods of clinical examination of the liver are generally adopted. The first consists in estimating its size and marking out its position by palpation and percussion. The physical qualities, such as roughness of the surface, consistence, presence of tumor, etc., may be determined in the same way. The second method, of infinite complexity, is based upon what we know of the functions of the hepatic cells and of the circulation of the liver in health and disease. Our knowledge in this direction is increasing, but it is often inadequate. Only by more careful clinical examination, by a closer study of morbid anatomy, and, above all, by a more thorough examination of the excreta, the urine, and fæces, shall we in future be able to arrive at more definite conclusions in the diagnosis of hepatic diseases.

The liver fills the right hypochondrium, its upper smooth surface being in such close proximity with the arch of the right diaphragm that the organ moves up and down with each respiration. The lower or visceral surface is somewhat concave, and this concavity may be increased by pressure. The gall bladder toward the anterior border, the lobus Spigelii, and the inferior vena cava near the posterior border are the most noteworthy points on this surface. The anterior margin is sharply defined, and presents a notch which can often be felt through the walls of the abdomen in cases of hypertrophy. In palpation care must be taken not to mistake the margin of the rectus muscle for the notch.

The upper and posterior margin is more constant in its position, is rounded, and firmly fixed to the diaphragm and spinal column by the coronary ligaments and the strong connective tissue around the inferior vena cava.

The right extremity is rounded, whereas the left is somewhat sharp and pointed. Only a small portion of the left lobe comes in contact with the walls of the abdomen. The anterior border comes to the margin of the ribs, but is somewhat variable in its position, and may be felt a few lines below the costal border.

In making a physical examination of the liver the stomach and bowels should be as nearly empty as possible. Fecal accumulations

in the hepatic flexure of the colon may give rise to a mistake in diagnosis.

In most cases we are not able to palpate more than the anterior portions of the upper and under surfaces and the anterior border. Glénard has recommended the following method of palpation: "The patient lying on his back with his legs extended and shoulders a little raised, the examiner sits on the couch facing the patient. He first inserts the four fingers of his left hand under the lumbar region, so that the middle finger is in its whole length just below the edges of the ribs, its tip being at the costo-vertebral angle; the thumb will then be in front and freely movable. The right hand is next placed on the front of the abdomen, the palm being in the middle line and a little below the umbilicus, and the fingers pointing to the right, obliquely downward and outward. The lumbar region is then raised by means of the fingers of the left hand, while the abdominal walls are depressed and the intestines pushed upward by a rotatory movement of the right hand. The bulb of the right thumb is then so placed that it can readily appreciate any change in position of the subjacent viscera with the respiratory movements. Thus, if the liver be enlarged, it will be felt descending on the thumb during inspiration, and by suitable movements of the thumb its form and consistence can be appreciated. In atrophy the condition also will be appreciated, as the thumb will fail to reach the gland on the fullest inspiration." Glénard believes that by the adoption of this method the pathology of many obscure cases of gastro-hepatic disease will be explicable.

Another method of examination has been recommended by Parkin: The patient is placed on the left side, the trunk in a position of flexion, the weight of the upper part of the body being taken off in order to thoroughly relax the abdominal muscles. The physician sits behind the patient, and, pressing one hand around either side, examines in detail the upper surface, anterior border, and under surface of the liver, together with the gall bladder, through the flaccid abdominal parietes.

The area of hepatic dulness occupies that portion of the surface where the liver comes in closest contact with the walls of the chest and abdomen. The upper border in the axillary line is at the eighth rib, in the mammary line at the lower border of the sixth, in the parasternal line at the upper border of the sixth, sometimes at the fifth interspace, and in the median line at the base of the xiphoid cartilage. The lower margin is found between the tenth and eleventh ribs in the axillary line and at the margin of the ribs, occasionally below them, in the mammary and parasternal lines. In the median line the lower border is midway between the end of the xiphoid cartilage and the umbilicus. Behind the upper margin of the liver reaches as high as the tenth rib, and the dulness below is continuous with that of the right kidney. Immediately above the line of absolute dulness there is an area of relative dulness where the liver is separated from the thoracic walls by the lung and diaphragm. This in the mammary line is on a level with the fifth interspace. The dulness is more marked over the right than over the left lobe, and near the lower margin the tone may become to a slight extent tympanitic. The lower margin can often be more accurately defined by auscultatory percussion. Careful examination with

the stethoscope will in some diseased conditions reveal a friction sound on deep respiration, which may be due to perihepatitis or to the roughened surface of nodular growths coming in contact with the walls of the chest or abdomen. A very limited perihepatitic inflammation will sometimes cause a well-marked friction sound.

The gall bladder extends across the under surface of the right lobe. Its fundus occupies a notch in the anterior margin at the junction of the eighth and ninth costal cartilages. This is a most important region, of which the student should obtain as accurate a knowledge as possible by palpation, so that he can appreciate differences in diseased conditions.

In arriving at a correct conclusion as to the situation, size, form, and consistence of the liver the following points must be noted: In infancy it is proportionately large, filling the right hypochondrium and the greater portion of the left. The upper margin of hepatic dulness may rise higher than in the adult, and the lower border may extend some distance below the margin of the ribs. In old people an atrophy of the organ sometimes takes place which must not be mistaken for cirrhosis.

Changes of Position.

In an abnormal conformation of the thorax from rickets or caries of the spine the liver may be made to assume an unusual position. Habitual constriction of the thorax, such as results from the practice of tight lacing, may change both its form and position. The liver may be displaced in various ways, to be described farther on, and give the idea of enlargement when it does not really exist.

The upper margin may not be made out on account of pleuritic effusion or consolidation of the right lung. Sometimes the right kidney is so displaced and attached to the liver that it may be mistaken for a portion of the latter organ. Tumors situated immediately above and below the liver also lead to an error in diagnosis.

In many cases it may be difficult to estimate the size of the liver, owing to the presence of inflammatory thickening or the formation of a perihepatic abscess. Gaseous distention of the gastro-intestinal tract may reduce the normal area of hepatic dulness by pushing the liver upward, so that its anterior border does not come near the anterior wall of the abdomen. In some cases the distended intestines are found between the superior surface of the liver and the wall of the abdomen. Very frequently this is accompanied by morbid changes in the organ, such as diminished resistance on the part of the parenchyma and the formation of furrows on the anterior surface of the liver, or of dilatation of the lower aperture of the thorax resulting from ascitic distention of the abdomen. In some rare instances this phenomenon occurs as a physiological condition when the transverse colon occupies an abnormal position between the liver and the border of the ribs.

Changes of Form.

These may be divided into two classes: (1) Congenital, and (2) Acquired.

The Congenital Changes of Form.—(*a*) The left lobe of the liver is enlarged, sometimes greater than the right; (*b*) Hypertrophy of the

lobus Spigelii; (*c*) A small organ, the hepar succedaneum, generally found in the ligamentum suspensorium; (*d*) Lobulation of the liver, a condition similar to that found in the kidney and a result of hereditary syphilis.

(2) *The Acquired Changes of Form.*—1. The effects produced by pressure of the ribs in certain varieties of enlarged liver, such as Liebermeister's furrows. 2. Changes in form produced by clothing, such as the corset liver. 3. Flattening of the upper surface, the result of unusual depression of the right diaphragm. 4. The liver assumes an almost globular form in some cases of scoliosis with narrowing of the right half of the thorax. 5. Interstitial hepatitis is one of the most frequent causes of acquired changes in form. This often results in extreme contraction of the left lobe. Marked lobulation is sometimes produced by partial inflammation and cicatrization. 6. In some cases of obstruction of the cystic duct the liver is dragged down by the weight of the distended gall bladder and somewhat changed in form. A portion of the right lobe extends lower than the remainder of the organ, giving the anterior and lower margin an irregular shape. Sometimes this amounts to a tongue-like process which is mistaken for a tumor. Hypertrophy of the lobus Spigelii has of late been mistaken for a distended gall bladder. A case has been recently reported in which a large and freely movable lobule attached to the lobus Spigelii was removed.

The corset liver is usually produced as follows: The organ is folded upon itself in such a way that the concavity of the under surface is increased; atrophy takes place, so that a groove or furrow is formed. This may become so deep as to separate the liver substance into two parts connected simply by a fibrous band. If at the same time the ligaments are lax, the pressure downward may change the position of the organ, so that the lower segment will float in the abdominal cavity. A coil of intestine is sometimes found lying in the furrow between the band and the walls of the abdomen. A case is mentioned by Frerichs in which this lower segment became adherent to the spleen. In this deformity the flow of bile may be partially obstructed and the formation of calculi be thus favored.

Changes in Size.

(1) **Simple Hypertrophy of the Liver.**—By this term is meant an enlargement of the liver due to increase in the number and size of the hepatic cells, without any further change in the histological structure. A number of cases have been recorded under this head which really do not belong to it; for instance, the enlarged liver of drunkards may be due to congestion, fatty infiltration, and increase of connective tissue. The liver of diabetes, which has been described as one of simple hypertrophy, often presents other changes besides those of enlargement.

In leucæmia the hypertrophy which was thought to be simple in character is really due to the presence of lymphoid tissue in Glisson's capsule and between the cells in the hepatic lobules.

The enlargement of the liver so often found in those who live in tropical countries is nearly always the result of congestion or malaria.

The possible existence of a simple hypertrophy has been demonstrated by the experiments of Ponfick and others in the regeneration of hepatic tissue.

(2) **Simple Atrophy of the Liver.**—This condition occurs in senile marasmus, and is of the same character as the senile atrophy of the other organs of the body. In marasmus from any cause the liver may become atrophied to one third its normal volume. This condition was formerly described as resulting from the ingestion of lead, arsenic, mercury, and antimony. In such cases there is destruction of the hepatic cells and an increase of connective tissue. They are therefore described under Cirrhosis (page 495). The same may be said of that form of atrophy which is found in cases of perihepatitis and peritonitis.

In simple atrophy the liver may be reduced to one half or one third of its original volume. The diminution of volume is often not uniform, but is more marked near the anterior margin of the right and left lobes. The whole organ is more pliable and its color darker than normal. The hepatic cells are diminished in size and contain brown or brownish red granules. The older writers mentioned many symptoms under this heading which more properly belong to cirrhosis.

When in an individual suffering from marasmus there is a gradual lessening of the area of hepatic dulness, and at the same time an insufficient amount of bile secreted, jaundice and ascites, with other symptoms of obstruction of the portal circulation, being absent, simple atrophy of the liver may be suspected.

HEPATALGIA.

HEPATALGIA is marked by a neuralgic pain deeply seated in the region of the liver, not attended by organic changes or febrile disturbance. Frerichs, while doubting the genuineness of many of the recorded cases of hepatalgia, states his belief in the existence of a neuralgic affection of the hepatic nerves independently of gall stones. In such cases he thought the whole course of the disease differed from that of biliary colic. He gave the history of what he thought was one of genuine hepatalgia, in which the attacks occurred every four weeks. On reading the history one is not at all convinced that it might not have been a case of biliary calculi.

This affection seems to have been studied more particularly by Anstie, who devoted a chapter to it in *Reynolds's System of Medicine.* According to his account, the disease occurs in nervous subjects who suffer from neuralgic pains in other parts of the body. One cannot help thinking that in some of the cases described by Anstie the pain might have been produced by calculi in the cystic duct, and was consequently not accompanied by jaundice. Harley does not think that hepatalgia exists apart from organic disease. It is probable, however, that cases of true hepatic neuralgia exist which are marked by exacerbations of pain and tenderness over the surface of the liver. It is not

likely that an organ so richly supplied with nerves should be exempt from a condition which is known to be present in other viscera. It may be distinguished from abdominal neuralgia by the absence of the tender points of Valleix and by the tenderness being simply limited to the liver. It is distinguished from biliary colic by the absence of vomiting and of the peculiar sense of constriction.

Hypochondriacal patients often complain of pain in the right side, which is to be distinguished from hepatalgia.

TREATMENT.—Quinine should be administered on account of the probable presence of malaria. The constitutional treatment which is found of service in neuralgia in other parts of the body should be adopted. Iron, tonics, rest, fresh air, and massage should be prescribed. Anstie found muriate of ammonia of great service in some of his cases.

DISPLACEMENTS OF THE LIVER.

ETIOLOGY.—The causes of hepatic displacement may be divided into three classes, as follows:

1. Those existing above the diaphragm, serous or purulent pleurisy, pneumothorax, and thoracic tumors. Effusion into the pericardium produced marked displacement in a case reported by Frerichs. The effect of effusion into the right pleural cavity when in large quantity is to depress the liver. In some cases the under surface is convex rather than concave. When effusion occurs in large quantity in the left pleural cavity, the liver is pushed toward the right side and downward. 2. Tumor or abscess existing between the liver and diaphragm which presses the liver directly downward and to the left, or in some cases causing a rotation of the organ. 3. In a third class of cases the displacement is due to a relaxation of the ligaments, and occurs more frequently in women. The term "floating liver" has been applied to these. Winckler gives the following causes which act in succession; (1) Pregnancy at full term; (2) pendulous abdomen; (3) hepar pendens; (4) stretching of the ligaments; (5) tearing and twisting of the suspensory ligament. In order to more correctly appreciate the strength of the ligaments and causes of displacement, Faure made a number of experiments on the cadaver. He found that it required seventy to seventy-five pounds to produce rupture of the ligaments, and concluded that in some cases there existed a morbid predisposition which, together with a depraved state of the nutrition, produced weakening of the ligaments. Tight lacing, as a rule, produces a change in form rather than in position, but both may occur in the same case. It is reasonable to suppose that in cases where there is a predisposition to displacement tight lacing may have a direct effect in displacing the organ downward. Among the active causes may also be mentioned coughing, sneezing, and vomiting. One case is recorded in which the coughing of hay asthma was supposed to be the cause. Landau gives as a cause rapid emaciation and disappearance of fat from the abdomen. A lax pendulous abdomen is mentioned in 19 out of 55 cases, all females, collected by the writer. Glénard is of the opinion

that slight displacement of the liver is present in the majority of women who have borne children. He found the lower margin as low down as the anterior superior spine of the ilium in 3 out of 40 such cases. The same author gives as a cause of displacement a general prolapse of the abdominal wall. Violent effort is given as the cause in 4 cases, all of which are males. The remains of an old echinococcus cyst in the suspensory ligament is mentioned in one instance. In one case old adhesive bands resulting from an old perihepatic inflammation drew the liver out of position. Carcinoma is given in one case. Meissner's theory, supported by Leopold and Sutigen, is that in some individuals there is a congenitally long suspensory ligament, the meso-hepar, but this has not been demonstrated.

Symptoms.—A sudden onset was noticed in 5 of the recorded cases. The symptoms present were pain in the abdomen, rapid and irregular pulse, followed by a feeling of weight and dragging, with more or less severe symptoms of dyspepsia. The pain differs in character and intensity, sometimes dull and dragging and sometimes sharp and lancinating, beginning in the right side and shooting up to the shoulder and neck, most violent when the patient lies on the left side, moves about, bends backward, stoops in lifting heavy weights, or when an attempt is made to push the organ downward or toward the left. Bending forward and supporting the tumor with the hands or bandages affords relief. Eructations, nausea, cold sweats, and an anxious expression, when accompanied by violent pain and jaundice, are suggestive of the possibility of hepatic displacement. In the great majority of cases reported the onset was gradual, and the symptoms noticed were a feeling of weight in the abdomen and a dull pain, especially on exertion. In several the general symptoms of neurasthenia were present, in many those of dyspepsia, and in some nausea and vomiting. Jaundice of a severe character occurred in 5 females and 1 male, slight jaundice in 4 females and 2 males.

Physical Signs.—The physical signs are as follows: The presence in the abdomen of a tumor which can be readily felt and which is of the shape, size, and consistence of the liver. The tumor was found on the right side of the abdominal cavity in 41 females and 8 males, on the left side in 1 female and 3 males, in the right and centre abdomen in 3 females and 4 males. One of the most important points is the possibility of replacing the liver. In the great majority of cases this could be done. Tympanitic resonance is found over the normal area, which should change to dulness when the liver is replaced. There is also change in the position of the liver with change in posture of the patient—in other words, mobility of the organ.

Cantani and Leopold claimed that there was a gradual change from dulness to tympanitic resonance over the tumor toward the inferior border. In some cases Winckler was able to touch the greater part of the inferior surface with his hand, and recognized distinct grooves. He could not, however, make out the gall bladder or distinguish it from coils of intestine. Leopold, on the contrary, claimed to have found behind the inferior border a tumor suggestive of the gall bladder. In a case reported by Barborroti the small lobe was extremely hard and the larger lobe was slightly indurated, due probably to interstitial hepatitis.

In cases of displacement due to distended intestine the liver may be so pushed upward and backward that the coils of inflated bowel fill up the whole subthoracic space subjacent to the lower border of the lungs and heart, bounded posteriorly by the liver and anteriorly by the lower portion of the thoracic and upper part of the abdominal walls. The hepatic dulness in its perpendicular diameter may ultimately disappear, and as a consequence the pulmonary resonance may be continuous with that of the intestine, the anterior border of the liver being so elevated and pushed backward that it is no longer near enough to the anterior abdominal walls to give a dull note on percussion. In addition to the presence of gas in the intestine, a diminution in the capacity of the abdomen, produced by the presence of fluids in the peritoneal cavity or of tumors, especially those projecting upward from the pelvis, may cause such a displacement. The cause in such cases may be easily recognized, but when the intestine is so distended it will be impossible to determine accurately the size of the liver.

The degree of displacement varies very much in the cases recorded by the different authors, and the length of time during which the condition had existed before coming under observation can hardly be regarded as having much influence upon the extent of the trouble. Meissner reports a case in which the condition had evidently lasted for the same time as in another reported by Winckler—*i. e.* about two months. In the former the inferior margin of the organ reached to within two inches of the symphysis pubis, while in the latter it only extended six centimetres below the margin of the ribs.

Diagnosis.—Floating liver may be mistaken for ovarian cyst, movable right kidney with hydronephrosis, and cancerous omentum. The principal points to be remembered are—(1) The upper smooth surface, sharply defined anterior border, and notch ; (2) Tympanitic resonance over the normal area of liver dulness ; (3) The possible existence of a tympanitic note between the superior border of the tumor and the margin of the ribs ; (4) The possibility of partial or complete displacement when dulness is found in the normal area ; (5) The displaced liver can be partially or completely restored to its normal position.

Treatment.—It is of course not possible to retain the liver in position, but it would appear that the support of the abdominal walls is in many cases sufficient to prevent prolapse, and that the symptoms produced by dragging of the liver on the diaphragm are thus relieved. The liver has been successfully replaced and fixed in its normal position by Richelot. In cases of floating lobe of the liver fixation to the wall of the abdomen has been successfully performed by Billroth, Tscherning, and Gerard Marchant.

FUNCTIONAL DERANGEMENTS OF THE LIVER.

Under this heading will be considered those symptoms which are usually termed bilious, as well as conditions of the liver in which there is a temporary derangement of function. It is probable that changes

may exist temporarily in the hepatic cells from which the latter completely recover. It is also probable that the continuation of such functional derangements may lead to degeneration and permanent inadequacy.

The large size of the liver, the number and importance of the blood-vessels connected with it, led the ancient physicians to assign to it a place of great importance in the economy. Galen, for instance, taught that the liver was the centre of heat as well as for the manufacture of blood. These doctrines were taught until the time of Harvey, when the discovery of the circulation of the blood and of the functions of the lacteal system, especially the latter, seemed to disprove the theory that the liver had anything to do with the manufacture of the blood. As has often since occurred, the pendulum of medical opinion swung to the opposite extreme, and Thomas Bartholin in his defence of the lacteals and lymphatics against Riolanus, wrote an epitaph for the liver announcing the end of its dominion.

We have been enabled in more recent years to study the functions of the liver by experimentation upon animals, as well as by observations made after the formation of biliary fistulæ in the human subject, and thus to arrive at more correct conclusions as to the importance of this organ. The careful investigations of Bouchard and others upon the subject of auto-intoxication have thrown much light upon many hitherto obscure phenomena. We are, notwithstanding, still inclined to look upon the liver too much simply as a bile-producing organ, and to forget its other equally important functions. For instance, the late Dr. Copeland classified functional disturbances of the liver under three heads—(1) those in which the secretion of bile is diminished; (2) those in which the secretion of bile is increased; and (3) those in which there is secretion of morbid or altered bile. Harley gave the same classification in the chapter on Biliousness in his work on *Diseases of the Liver*, the last edition of which was published in 1884. This is incomplete—in the first place, because it gives too great prominence to the liver as an excretory organ, and in the second place it is of little use, for we have no means in the ordinary individual of finding out accurately whether the bile is diminished, increased, or altered. The passage of a large quantity through the bowels or its regurgitation through the stomach may be simply an evidence of a rapid emptying of the gall bladder, and is not a sure indication of increased secretion. Calomel, while it increases the amount of bile in the fæces, really diminishes its formation in the liver.

A careful study of the circulation in the liver is necessary before we can properly take into consideration the various functions of the hepatic cells. The principal peculiarity is its very low pressure, so markedly differing in this respect from the kidney. The low-pressure circulation, due to the fact that the blood has already passed through one set of capillaries, seems necessary to proper hepatic secretion. At the same time, this characteristic may lead to inactivity of the cells when from sedentary occupations or unhealthy condition of the thoracic organs a still lower pressure exists. The flow of bile may thus be retarded and a truly torpid condition of the liver brought about.

Normal Hepatic Functions.

The following are the principal functions of the liver which have been fairly demonstrated:

1. The formation of bile, which may be looked upon as a secretory and excretory fluid. It may now be stated as a settled fact that neither the bile pigment nor the biliary salts are ever found in the blood except as the result of cell activity. Quincke has shown that a substance nearly allied to, if not identical with, bilirubin results after an extravasation, and that it is formed only under the influence of the living tissues. It is not formed so long as the blood remains in the bloodvessels. In all cases, therefore, jaundice is the result of reabsorption of bile formed in the liver.

Schiff made a series of experiments on animals by the establishment of what he termed amphibolic fistulæ. A large fistulous aperture was made between the surface of the abdomen and gall bladder without the common bile duct being ligatured. Under these circumstances the bile will pass out through the free opening, and when the cannula is closed it will flow through the normal passages into the intestine. In this way the animals maintain about their normal state of health, and a more careful study can be made, as the flow of bile can be diverted from the ordinary channels at will.

Schiff found that the quantity of bile secreted was greater immediately after it had been allowed to pass into the intestine than when it flowed out through the external fistula. He also found that after the introduction of bile salts into the intestines through a duodenal fistula the bile was increased in quantity and the solids were increased in proportion to the liquid. Upon these facts he founded the theory of the "circulation of the bile"—viz. that a portion of the latter fluid was absorbed, came back to the liver by the portal vein, and formed part of the material for the secretion of fresh bile. He also found that increase of biliary secretion followed the introduction of biliary salts into the intestine when the portal vein was obliterated, thus proving that the bile may be formed from the biliary constituents which are brought to it through the arterial as well as through the portal circulation.

Experiments have been made by Baldi, under Luciani's directions, which proved that the coloring matter of the bile absorbed from the intestine and conveyed to the liver formed a part of the fresh bile secreted. He injected ox-bile into the veins of a dog which had a biliary fistula. The quantity of bile was increased and the color assumed a green tint, which is characteristic of the biliary secretion of the ox. Objections were made to the conclusions arrived at from this experiment that the green color might be due to a chemical change.

Prof. Wertheim of Lille by experiments proved to a demonstration that bile coloring matter introduced into the portal blood was immediately secreted by the liver. Chlorhæmatin, a coloring matter in the bile of the sheep and the ox characterized by a certain spectrum, when introduced into the portal circulation of dogs was afterward found in the bile flowing from the fistula.

2. The glycogenic function, by means of which the extra amount of

carbohydrates is prevented from passing into the general circulation and glycogén, is stored up in the hepatic cells. As to the ultimate destiny of glycogen, whether Bernard's or Pavy's view is correct, there is no doubt of the fact that the liver acts as a most important barrier to the accumulation of sugar in the general circulation.

3. The formation of urea, the end-product of the oxidation of nitrogenous matter, assists in the excretion of the latter by the kidney. Although this product is found in other parts of the body, the liver is the principal seat of its manufacture, as is shown by the fact that when the hepatic cells are destroyed, as in phosphorus-poisoning and acute yellow atrophy of the liver, the urea is very much diminished in the urine. In suppurative hepatitis, in cirrhosis, or in any disease whereby the parenchyma of the liver is to a large extent destroyed, the amount of urea eliminated is very much lessened. It would appear from recent investigations that in the liver the urea is formed principally from the red blood-corpuscles which are there destroyed. This would seem probable from the fact that it is increased in tuberculosis and the various cachexias. When there is an increased destruction of red blood-corpuscles the urea is increased. Certain poisons, as pyrogallic acid, which act as destructive agents in the blood also cause an increasd elimination of urea. The amount of urea eliminated under ordinary conditions depends on the integrity of the cell and the condition of the circulation. An increase in the secretion of bile causes an increase in the elimination of urea.

Some years ago the late Sir Andrew Clarke under the title of "renal inadequacy" described a class of cases "in which the kidney without any sensible alteration of structure that our modern means of investigation will enable us to determine cannot secrete a healthy urine." Such kidneys secrete a urine which, assuming the quantity to be commensurate with health, is low in density and is deficient in solid constituents, principally urea and its congeners. He then went on to state that the individuals who have this renal inadequacy are characterized by three things: They are seriously affected by slight colds and do not soon recover from them; they cannot repair quickly damage done to them; and "you cannot be sure of the results of the performance of an ordinary operation upon them."

In commenting upon this paper Dr. George Johnson, while giving Sir Andrew Clarke due credit for his keen observation in pointing out such cases, differs from him in the opinion that the kidneys are really inadequate. He says: "It must be admitted, I think, on careful consideration, that the theory of defective digestion and assimilation satisfactorily explains not only the deficiency of urinary solids, but also the leading characteristics of the patients so well described by Sir Andrew Clarke—the imperfect repair of injuries the result of accident or disease, their powers to contract disease, and the uncertain results of surgical operations which they may have to undergo. As a result of defective food conversion and assimilation the tissues of these patients are imperfectly nourished, and the materials for repairing the result of disease or accident are faulty."

While agreeing with Dr. Johnson that the theory of defective digestion and assimilation satisfactorily explains the condition met with in

this class of cases, I am inclined to the opinion that in some, at least, the liver, the great centre of metabolism, is the organ principally concerned, and that the term hepatic inadequacy might be applied to some, and renal inadequacy to others. The kidneys may be quite able to perform the work of elimination of the waste products if the blood conveyed the latter in a sufficiently oxygenated state. Moreover, the readiness with which such cases succumb to mild infectious diseases is due to the fact that the liver has to a great extent lost the power of guarding the system from poison.

4. Probably one of the most important functions of the liver is to act as a guard or barrier to the entrance of poison formed in the digestive tract into the general circulation. It has long been known that such metallic poisons as phosphorus and arsenic pass directly to the liver and produce in it important changes. Alcohol when taken in large quantities has the same action. Of late years, however, especially since the publication of the investigations of Bouchard and other French pathologists, the action of the liver in this respect has been more carefully studied and its true importance assigned to it.

5. The formation of fat and the elaboration of the blood in early life are also important hepatic functions. The large size of the organ in fœtal life would indicate this.

6. The destruction of blood-corpuscles takes place primarily in the liver. Bile pigment and urea are the principal compounds resulting from the process of disintegration (Hamilton). Some suppose the biliary acids to be the principal agents, and Kühne has described the dissolving of blood-corpuscles under the microscope when biliary acids are added.

When it is considered that all these processes are carried on in each hepatic cell, it will become quite evident that the derangement of one function will often result in the imperfect performance of others. Bouchard has demonstrated the fact that when the glycogenic function is impaired the hepatic cells lose their power of arresting poisonous alkaloids, and that these will appear more readily in the urine. Again, in cases of severe jaundice the formation of urea to a great extent ceases, and it is found in diminished quantity in the urine. This explains many clinical phenomena. For instance, in diabetes the system becomes easily poisoned. Septicæmia follows slight wounds or a fatal result may ensue from a comparatively mild attack of infectious disease.

Derangements of Hepatic Functions.

It is impossible here to take up in detail the derangements of the various functions. I shall make special reference to the importance of the liver as a guard or sentinel of the system against poisons. Bouchard has made the following statement: "The healthy man is both a receptacle and a laboratory of poisons. In fact, he receives them in his food, creates them by assimilation, and forms them in his secretions. The human body is the theatre of toxic elaboration carried on by the normal microbes which constantly inhabit the alimentary canal."

The general system is guarded by the liver from those many poisons which are introduced into or are found in the digestive tract.

It should also be remembered that the liver acts not only as a refinery, purifying the blood coming from the mucous membrane of the stomach and intestines, but that it acts, as it were, as a second laboratory, in which some of the more delicate processes are carried on to prepare the food for its ultimate destiny, the formation of the tissues of the body or the maintenance of animal heat. The poisons which are arrested by the liver may be divided into four classes:

1. Those which enter from without—(*a*) mineral, such as phosphorus and arsenic; (*b*) organic, such as result from decomposition, as from diseased meat, cheese, etc.

2. Poisons the result of the action of bacteria which are always found in the stomach, and those of fermentation in cases of dilated stomach.

3. Toxins produced by the bacteria of infectious diseases, such as typhoid, yellow fever, malaria, etc.

4. Poisons absorbed from the intestines.

Cases illustrating the effect of metallic poisons on the liver occur sufficiently often to make us somewhat familiar with the process, as, for instance, the action of an overdose of phosphorus in causing a destruction of the hepatic parenchyma. Too little attention is perhaps paid to the necessity of abstaining from highly seasoned food, game which has undergone decomposition, and very old cheese, as in all these toxins exist which have a directly deleterious effect on the liver. It must be remembered that in many cases the hepatic cell is sufficiently taxed to arrest poison normally absorbed from the digestive tract.

The second form of poisoning frequently exists in many of the so-called cases of biliousness. In one class of cases the amount of poison produced in the digestive tract may not be more than normal, but, perhaps from hereditary tendency, from nervous shock, or from the effects of previous disease, the hepatic cell is inadequate to the proper arrest of that poison in the liver and the general system becomes affected. Thus hepatic insufficiency is of great importance in many diseased conditions. In a second class an increased amount of poison is found in the stomach, due to abnormal processes of fermentation and consequent gastrectasis. In this form, which has been termed by some French pathologists "Bouchard's type of dilatation," the capacity of the stomach may not be greatly increased, and the condition may be overlooked unless a very careful examination is made. It results partly from an abnormal condition of the secretions and partly from a weakened muscular structure. The food remains in the stomach, fermentation takes place, when ptomaïnes are formed and taken up into the portal circulation. The liver may at first be equal to the extra task of arresting these, but after a time a weakened condition of the hepatic cell results, and ptomaïnes pass into the general circulation, thus affecting the nerve centres. In such cases, owing to temporary congestion, the liver may be slightly enlarged and tender, and a sense of weight is experienced in the right hypochondrium.

Owing to the circulation of ptomaïnes throughout the system a series of nervous symptoms are often established, such as insomnia, nightmare, hallucinations, vertigo, partial deafness, and disturbed vision. In some cases slight jaundice appears. In the successful management

of this condition it is necessary to remember that the immediate cause of trouble exists in the stomach, and that measures should be adopted to neutralize the poisons found and to restore the organ to a normal condition both as to its capacity and its functions.

The effect upon the liver of poisons which result from the introduction of infective bacteria into the system is a matter of great interest which will be discussed farther on. In typhoid fever, for instance, the liver is often so enlarged and tender that the abnormal condition can be readily appreciated by palpation. The jaundice which sometimes occurs may result from the direct action of the poison circulating in the blood, or perhaps from the action of the typhoid germs which pass up the biliary passages, producing an angiocholitis. An important fact must here be noted: the hepatic cell is often so injured by the poison of acute disease that after recovery a more or less permanent condition of hepatic inadequacy may result. This is noticed in cases of malaria. Then, again, in some cases the destruction is so great that death appears to result from that cause.

The possibility of the regeneration of the hepatic cells has been demonstrated by various observers. The examination of the liver of the cat, rabbit, and guinea-pig made some time after wounds had been inflicted has revealed the formation of new connective tissue, gall ducts, and hepatic cells in the liver, not only in the immediate neighborhood of the wound, but at some distance as well. A similar form of regeneration has been observed in the human liver which no doubt plays an important part in the renewal of hepatic tissue after its destruction by the poison of various infectious diseases. When a large portion of the organ has been destroyed by cancerous tumors or by echinococcus cysts a compensatory hypertrophy takes place whereby the functions of the liver are carried on as before. Ponfick was able to remove from one half to three fourths of the organ in animals without causing death. The liver tissue which remained took on a compensatory hypertrophy and the organ in time reached its normal volume. A somewhat similar regeneration takes place, to a limited extent, in cirrhosis. The hypertrophy of the liver found in rickets may arise from a similar cause.

Functional diseases are no doubt frequently the result of the absorption of ptomaïnes from the intestines. Food itself is poisonous. The aqueous decoction and the alcoholic extract of meat are both poisonous when injected into the veins of animals. When from disease or any other cause an abnormal amount of fermentation takes place in the intestines, a condition follows which is accompanied by well-marked symptoms, such as tympanites, the passage of large amounts of gas from the bowels, and the irritating character of the discharges, as sometimes shown by an inflammation of the skin in the region of the anus. If the fermentation is of a putrid character, the odor of the discharges may be very offensive, due to the increase of sulphuretted hydrogen. At the same time, owing to the absorption of poisons into the system, certain constitutional symptoms are noticed, such as a sense of fatigue, depression, vertigo, headache, and disturbance of sight. The complexion may be more or less muddy, having lost its clear character. Such a collection of symptoms is usually placed under the head of "biliousness," and not without reason, as the liver is no doubt inadequate to the

proper arrest of ptomaïnes formed in such large quantity. If the kidneys are in a healthy condition and equal to the extra strain of elimination, the symptoms may not be urgent, but if nephritis exists, grave signs of poisoning may at once appear.

It has been demonstrated by experiment that the urine is much more poisonous when toxins are formed in abnormal quantities in the intestines. The action of the liver in guarding the system from these toxins has been demonstrated in many ways by Bouchard. The alcoholic extract of poisonous meat is only half as poisonous when injected into the portal vein as when introduced directly into the general circulation. Blood drawn from the portal vein of a dog kills a rabbit in a dose of from thirteen to fourteen cubic centimetres, when it requires nearly twice the quantity if taken from the liver itself. Schiff's experiments prove the importance of the liver as a barrier to the introduction of intestinal poison into the system.

An objection to these views may arise from the fact that many individuals suffer for years from chronic constipation and maintain a fair standard of health. This may be explained in two or three ways: The hardened fecal matter does not allow of much absorption, and if the liver and kidneys are healthy, the absorbed toxins are either destroyed by the liver or removed by the kidneys as rapidly as they enter the circulation. It is, however, a well-known fact that individuals suffering from chronic constipation frequently exhibit symptoms of biliousness, such as headache and vertigo, as well as many mental peculiarities, hypochondriasis, tendency to melancholia, etc. These are no doubt the result of the action of ptomaïnes upon the nerve centres. It will thus be seen that whether the poison be derived from the stomach or intestines the process is much the same. If the power of the liver as a sentinel is lessened, the toxins ordinarily found in the digestive tract may circulate through the system, producing many of the symptoms of biliousness. If, on the other hand, an abnormal amount of poison is formed and absorbed, the liver, although at first healthy, may not be able to arrest it, and the system may thus become affected. In such cases, too, the liver may be temporarily or permanently injured, and may not afterward be able to exercise its normal functions. To maintain a good standard of health the hepatic cell should be able to perform its whole work.

In perhaps nearly all the so-called cases of biliousness a greater or less degree of hepatic insufficiency exists, whether this be (*a*) primary or (*b*) secondary.

(*a*) Primary hepatic insufficiency may be of an hereditary character. In many individuals the hepatic cell will only do its work under the most favorable circumstances. In such a bilious condition may be produced, on the slightest provocation, chilling of the surface of the body, certain common articles of diet, or over-exertion. Again, hepatic insufficiency may result from nervous exhaustion. In such cases a disturbance of the vaso-motor circulation is followed by a weakened functional condition of the cell. A physician who has a large experience in the management of neurasthenic cases not long ago informed me of the frequency of functional derangement of the liver in his patients, and of the great necessity of first directing his efforts to the removal of that condition. The direct effect of mental emotion upon the liver secretion is

well illustrated in the attacks of sudden jaundice which sometimes follow fright or other emotions.

(*b*) Secondary hepatic insufficiency may result from too great indulgence in certain articles of food and drink, and is more likely to occur in those of sedentary habits. Alcohol is the principal offender, and may be termed the great enemy of the liver.

Finally, the poisons absorbed from the digestive tract are a more frequent cause of hepatic derangement, sometimes producing the acute and sometimes the chronic form.

It is obviously impossible to properly describe all the various constitutional symptoms which are found in bilious patients, such as a bitter taste in the mouth, dyspepsia, cardiac irregularity, character of the alvine evacuations, condition of the blood, or the various nervous phenomena. I will merely refer to the headache, in the form of a dull pain in the forehead, complained of on waking and continuing for several hours during the day. The patient at the same time suffers from a dull pain and a feeling of weight in the hypochondrium, and afterward passes urine loaded with lithates. This variety of headache is to be distinguished from megrim, which is of purely nervous origin.

However, as Murchison says, even in many cases of megrim the pain is produced by the action of toxin on the nerve centres, and the condition is often found in lithæmic or gouty people. Vertigo, temporary dimness of vision, double vision, and sleeplessness are often experienced by individuals of a gouty tendency.

It is necessary here to mention that many recent experiments seem to demonstrate that the liver under certain circumstances is capable of increasing the virulence of toxins instead of lessening it. Teissier has shown by experiments on dogs that certain poisons of great diastasic power when introduced into the portal vein acquire greater virulence by passing through the liver. More rapidly fatal symptoms were produced than when their toxins were injected into the systemic veins.

Treatment.—In the treatment of functional disturbances of the liver it is of great importance that the origin of the difficulty should be discovered and the cause if possible removed. The performance of the healthy function of the hepatic cell depends so largely upon the general health of the individual that those means which are adopted for the building up of the constitution are of great value. Care should here be taken that in the carrying out of such measures the patient is not overfed, thus increasing rather than diminishing the liver trouble. I have recently had under observation a case of eczema which illustrates this point. The patient was overfed, because it was thought that the eczema was caused by a debilitated state of the system. Symptoms of biliousness developed, and the skin affection increased. Upon a carefully restricted diet and the use of purgatives the skin disease rapidly disappeared and the general health improved. Those articles of diet should be avoided which contain toxins or from which toxins are readily produced in the stomach. Large amounts of starchy food which are liable to undergo fermentation should be interdicted. Game more or less decomposed is especially injurious, as well as all kinds of highly seasoned food and "made-up" dishes. We have in milk an excellent form of diet, which, while not irritating to the liver, has a diuretic action, thus

favoring the excretion of toxins. The diet and regimen of a bilious subject should be similar to those of an athlete when in training for a race.

As stated in the early part of this section, the condition of the circulation is of great importance to the proper performance of the hepatic functions. This can be improved by exercise, which expands the chest and increases the force of the heart's action. Then the emptying of the gall bladder and bile ducts may be facilitated by massage or by such exercise as horseback and bicycle riding.

Before discussing the various remedies which are used in hepatic derangements it is well to emphasize the great advantage of free purgation. A complete emptying of the intestinal tract not only promotes the free excretion of bile, but also removes poisons which if allowed to remain might become absorbed. For this purpose calomel probably still holds its position, although podophyllin and euonymin have the advantage of acting as hepatic stimulants. Calomel, when given in small doses frequently repeated, probably is partly changed to the bichloride in the bowels, and we know that the latter has a decidedly stimulating action on the liver. The proper elimination of bile is of great importance for two reasons: it is necessary to intestinal digestion, and through it many poisons are eliminated from the blood.

The poisonous substances of the bile exist both in the bile coloring matter and in its salts, and they would act much more injuriously when absorbed into the general circulation were they not neutralized by the healthy tissues and partly eliminated by the kidneys. It has been proven that one of the best agents for increasing the biliary secretions is bile itself. A clear demonstration of this fact has recently been made by Pfaff and Balch, whose observations are published in the *Journal of Experimental Medicine*, January, 1897. When administered by the stomach it passes to the liver and stimulates the hepatic cells to greater action. When, for instance, ox bile is given to a dog, the bile secreted acquires a deep green color and possesses an odor peculiar to that of the ox. Although the amount of bile can in this way be increased, it is made more dense and will not flow as readily through the hepatic ducts. Olive oil, on the other hand, increases the amount of bile and renders it more liquid. Rosenberg has shown by means of a biliary fistula in dogs that the hypersecretion begins in from thirty to forty-five minutes after the ingestion of the oil. Salicylate of soda and salol act in the same way, but when used for a length of time have a tendency to produce congestion of the liver. On this account Lepine prefers benzoic acid and benzoate of soda. Turpentine, podophyllin, and euonymin are well-known hepatic remedies. I have used olive oil in some cases of obstructive jaundice with great benefit. In one case the symptoms were so pronounced and of such duration that the surgeon who saw the case in consultation wished to operate. The administration of large doses of olive oil was followed by relief and complete cure. The patient left the hospital four years ago, and there has been no return. In another case I found salicylate of soda and phosphate of soda quite as effective.

Calomel is not an hepatic stimulant, but, acting on the small intestines and probably by reflex action on the gall bladder, produces con-

traction of the latter and consequent emptying of its contents. In a case described by Whiteman at the last meeting of the Ontario Medical Association the contrary action of salicylate of soda and calomel was plainly demonstrated.

The action which the so-called cholagogues exert on the secretion of bile is still under discussion. The effect of the various toxins in increasing the flow—that of malaria, for instance—would seem to indicate that it is possible by drugs to influence the biliary secretion. It is extremely difficult by ordinary clinical investigation to accurately estimate the effect of drugs in this particular. An increased amount of bile in the fecal discharges may arise, as Rutherford has stated, from various causes: (1) stimulation of the hepatic secretory apparatus; (2) stimulating the bile-expelling apparatus; (3) removing the catarrhal or congested condition of the orifice of the common bile duct; (4) removing from the intestines substances which when taken up by the portal circulation would exert a depressing action on the hepatic secretion; (5) stimulating the intestinal glands, and thus producing drainage of the portal system—"unloading the liver," as the process is sometimes called.

Rutherford made a series of investigations by experimenting on animals, and published an elaborate report in which he gave the following as the most powerful hepatic stimulants: sodium phosphate, mercuric chloride, ipecacuanha, colchicum, jalap, aloes, colocynth, sodium benzoate, and sodium salicylate. Rhubarb and dilute nitro-hydrochloric acid were found to be feeble stimulants to the hepatic secretion. He also discovered that the medicines which acted as intestinal stimulants, such as sulphate of magnesia, gamboge, and castor oil, diminished the secretion of bile, and that bile itself when administered internally increased the secretion. All investigations made subsequently to those of Rutherford confirm the conclusions of the latter with regard to the action of bile and the biliary salts when taken into the system. Paschkias, Nissen, and others who have made investigations since the publication of Rutherford's paper have quite disagreed with the latter's conclusions with regard to the action upon the liver of any compound except bile and the biliary salts (Gamgee).

It is probable that experiments on patients who have biliary fistulæ as a result of operation will in the future set at rest a good many of these vexed questions.

The taking of large quantities of water an hour before meals will, by flushing the liver, assist in the elimination of poisons.

Have we any certain methods of improving the glycogenic function? Antipyrin has been found by experiment to increase the amount of glycogen stored in the liver. Dupont has shown that when dogs are fed on flesh the glycogen is increased in the liver by the administration of the bicarbonate of soda. On the other hand, phosphorus, antimony, and arsenic in large doses destroyed the glycogenic function. Pavy in the Croonian Lectures recently delivered expressed his firm opinion that the glycogenic function depends largely upon a healthy condition of the vaso-motor system and the nerve centres. It would then appear that one should be directed in that way, and for this reason arsenic is often found useful.

In the manufacture of urea the liver plays an important part, and many of the symptoms of biliousness no doubt result from the sub-oxidation of nitrogenous products. For this reason the various forms of treatment which have for their object the promotion of metabolism, such as massage, bathing, and gymnastics, are of service. Some mineral waters are of value, especially Vichy and Carlsbad. I have for a long time prescribed Carlsbad salts for this condition, and have been well satisfied with the results. Salicylate of soda and salol I have also used successfully.

I would here wish to emphasize the importance of maintaining the integrity of all the functions of the hepatic cell, and, as this integrity is most frequently destroyed by toxins from the digestive tract, one of the objects of treatment should be to neutralize those already there and to prevent the further formation of an abnormal amount. For such disinfecting purposes Bouchard recommends betanaphthol, salol, and calomel.

JAUNDICE.

Definition.—Jaundice is a condition in which the coloring matter of the bile is found in the tissues, the blood, and other fluids of the body. It is a symptom of a disease, and not a morbid entity, but, on account of its importance and the difficulty of ascertaining in all cases its cause, a special description is necessary.

The term "acholia" denotes the suppression of the secretion of bile, although it is often used in the sense of complete biliary obstruction. By pigmentary acholia is meant an absence of pigment in the hepatic secretion. By the term polycholia, on the other hand, is meant a superabundance of bile, a condition which, according to the older writers, is sometimes a cause of jaundice.

Varieties.—Jaundice has been divided into two forms, the obstructive and non-obstructive. The terms hepatogenous and hæmatogenous which have been given to these forms should be avoided, as they indicate that the important constituent parts of the bile may exist already formed in the blood. Although it is extremely difficult to explain some cases on any theory, it is now fairly well established that bilirubin, as detected by Gmelin's test, does not exist in the urine unless it has been previously formed in the hepatic cell and passes into the blood. Bile pigment and biliary acids are the direct products of hepatic activity. The terms extra-hepatic and intra-hepatic jaundice, used by Eichhorst and others, seem preferable to the terms obstructive and non-obstructive, because the existence of the non-obstructive form is still a matter of doubt. In the extra-hepatic form the flow of bile is in some way arrested in its passage from the lobule through the larger ducts.

Obstructive Jaundice.

The various forms of obstruction are given in another article in detail, and are consequently only briefly referred to here.

1. Abnormal conditions in the lumen of the bile ducts, the result either of some pathological state of the bile itself or of the presence of a foreign body. Under this head might be mentioned inspissated bile and gall stones. It is not established that thickened bile will produce obstruction, although it is considered probable. Biliary calculi are the most common cause of obstruction. Among the foreign bodies found in different cases are needles, fruit, small cherry stones, echinococcus cysts, and the remains of the distomum.

2. Conditions arising in the wall of the bile ducts, thickening of the mucous membrane from catarrhal or suppurative inflammation, spasmodic closure, and permanent stricture of the common bile duct. Catarrhal inflammation may be limited to the smaller biliary radicles, and thus produce obstructive jaundice in cases which might at first be considered as belonging to the non-obstructive forms. Carcinoma, lipoma, and polypus may grow from the walls of the biliary canal. Contraction of the bile ducts from ulceration the result of gall stones has been known to produce obstruction. Stenosis may also follow as a result of the ulceration of typhoid fever or of catarrhal or suppurative inflammation. Icterus spasticus and icterus paralyticus represent two supposed forms of obstruction of almost opposite character. It is doubtful if in any case a spasmodic contraction of the intra-hepatic biliary ducts ever causes jaundice.

3. Conditions outside of the biliary canal, as tumors, contractions, and thickenings from perihepatitis. The form of tumor most frequently found is carcinoma, either primary or springing from the pylorus or duodenum. Carcinomata arising from the hepatic flexure of the colon, from the head of the pancreas, mesentery, and retro-peritoneal glands may act in the same way. Obstruction of the bile duct sometimes results from perihepatitis, as well as from chronic inflammation of the wall and surrounding connective tissue. A thickening of the mucous membrane of the duodenum near the orifice of the ductus communis choledochus may produce sufficient obstruction to cause jaundice. Among other causes may be mentioned pregnancy, aneurysm, tumors of the kidney, floating kidney, right-sided diaphragmatic pleurisy, acute perihepatitis, bands of contraction from chronic peritonitis, and also abscesses, hepatic and perihepatic.

Chronic constipation is sometimes a cause of jaundice, a fact which Frerichs and Murchison explained on the theory that the bile is reabsorbed from the intestine. Hamilton, however, is of the opinion that in such cases pressure on the common bile duct made by the fecal mass is the cause. He further states that very little pressure will produce obstruction, and that in cases in which a crowquill will pass through the stenosed part the duct may be dilated behind to the size of the small intestine. Sharp curves or kinks in the common bile duct, the result of displacement, may cause jaundice.

Non-obstructive Jaundice.

Non-obstructive or intra-hepatic jaundice is found in such conditions as phosphorus-poisoning and acute yellow atrophy, when the hepatic cell itself is the seat of disease and when the larger biliary passages remain free.

Jaundice occasionally occurs after great mental emotion, as well as after a chill. In such cases there is no obstruction of the larger ducts, but it is still uncertain as to whether an occlusion may not exist in the smaller biliary radicles. Sir Thomas Watson relates the case of a medical student who became jaundiced while passing his final examination. Cornil is of the opinion that in the majority of cases of jaundice from poisoning, etc. the epithelial lining of the smaller bile ducts becomes swollen, and that obstruction is thus produced. Liebermeister has proposed the term akakthetic jaundice for that form caused by pathological changes in the liver cells on account of which they are unable to retain their secretion. Frerichs, supported by Murchison, was of the opinion that in many of these cases there was an excessive secretion of bile and consequent reabsorption of the extra quantity. Such cases of polycholia may occasionally occur, but intra-hepatic jaundice is not usually produced in this way.

Bile is secreted under very low pressure, and it is not improbable that changes in the circulation may cause it to flow from the cells into the veins rather than into the biliary radicles. Jaundice from chills or from mental emotion may be thus explained, as also the jaundice which often occurs in cardiac insufficiency and in pneumonia.

Cases of intra-hepatic jaundice may be classified as follows:

(1) Organic changes in the liver structure, as in acute yellow atrophy and the various forms of cirrhosis.

(2) Disturbances of innervation, acute and chronic congestions of the liver. Under this head may be mentioned jaundice from emotional disturbances, that which occurs during menstruation or at some definite period after menstruation, and that which arises from cardiac insufficiency.

(3) The toxins of the various infectious diseases, malaria, typhus, typhoid, relapsing and cerebro-spinal fever, of variola, scarlatina, acute rheumatism, and epidemic jaundice.

(4) Animal poisons, whether found in the body or introduced from without, as that of extensive burns, snake-poison, or in the condition known as septicæmia.

(5) Mineral poisons, as phosphorus, mercury, antimony, and copper.

(6) Chloroform and ether.

The jaundice which occurs in cases of starvation may arise from the formation of a toxin in the blood from circulatory disturbances, or, as it has been held by some, from a thickened condition of the bile, leading to obstruction.

Schüppel gave prominence to an abnormal condition of the respiratory organs occasioning jaundice; for instance, when the chest movements are restricted, a passive congestion follows and the flow of bile may be retarded.

Leichtenstein places all cases of intra-hepatic hæmatogenous jaundice under two heads: (1) When the biliary canals are patent and the liver functions normal jaundice may arise from the destruction of red blood-corpuscles (hæmoglobinæmia, transfusion of blood, resorption of large extravasations), a polycholia or ptero-chromin is produced. A very dense bile is the result, and this may cause a partial obstruction to the flow through the passages. (2) Jaundice the result of injury to hepatic

cells from the toxins of infectious diseases. Here there is a disturbance of hepatic cell function. According to Minkowski, the hepatic cell has the function not only of separating out the bile, the sugar, etc. from the blood, but also of discharging the appropriate substances into the blood-vessels, the lymph channels, and into the biliary radicles. This function may be destroyed by toxins. The diffusion icterus of Liebermeister is similarly explained.

Extra-hepatic Jaundice.

The manner in which the coloring matter of the bile is reabsorbed into the blood was studied by Saunders in 1745 in experiments by ligating the common bile duct of dogs. His conclusions have since been abundantly verified. When obstruction occurs the bile, which distends the passages and gall bladder above the lesion, first passes along the lymphatics into the thoracic duct, and thus into the vena cava. It was formerly taught that after a time, when the intra-hepatic ducts became dilated, the bile was directly absorbed into the venous capillaries and passed into the hepatic vein. Vaughan Harley has, however, demonstrated the fact that the bile at all times passes through the lymphatics into the superior vena cava. He made two series of experiments on dogs. In one he ligated the common bile duct and the thoracic duct at the same time, and in the other he ligated the thoracic duct some days after he had operated on the common bile duct. In the former series the bile did not appear in the urine for some days, and in the latter it disappeared soon after the thoracic duct was tied, and returned after an interval of some days. It was found on dissection that after ligation of the thoracic duct anastomotic lymph channels were established connecting with the vena cava.

Harley arrived at the following conclusions concerning the reabsorption of the bile:

(1) That in obstructive jaundice the bile does not find its way into the general circulation through the blood capillaries.

(2) That the bile is absorbed by the lymphatic vessels alone, and passes through the thoracic duct into the general circulation.

(3) When the thoracic duct has been ligated for some days "supplementary ducts form by the coalescence of either new or pre-existing collateral lymphatics from the thoracic duct at a point below the seat of ligature, through which the lymphatic stream passes vicariously into the right innominate vein."

If the obstruction is complete, the bile ducts on the hepatic side of the stricture become after a time filled with mucus, so that bile pigment may entirely disappear from the larger channels, while the smaller ones and the hepatic cells remain deeply stained. The lymphatics of the liver are then first stained with bile pigment. Bile pigment can be detected in the urine twenty-four hours before the tissues of the body become changed in color. It is found in the normal tissues as well as in any serous exudation which may take place.

Bile has been shown by experiment to be exceedingly poisonous. This property exists especially in the coloring matter and in the salts. Flint looked upon cholesterin as the poisonous ingredient.

According to Bouchard, the biliary acids are ten times less toxic than biliverdin, and bile itself is nine times more toxic than urine. The general system is protected from the poison in two ways: (*a*) by the neutralization of a large proportion of the coloring matter by its deposition in the tissues; (*b*) by its rapid elimination through the kidneys. The prognosis, therefore, in a case of jaundice depends largely on the integrity of the kidney.

Pathological Anatomy.—All portions of the body, as well as any serous exudations which may exist, are stained in jaundice. The serum and coagulum of the blood become yellow, and the clot breaks down rapidly in the later stages of icterus. Bile acids have not been found in the blood, probably on account of their rapid decomposition. Adipose tissue, especially that around the heart, presents a sulphur yellow color. Even the vessels of the intima, the hair, and teeth become affected. The cornea and sclerotic frequently escape, and nerve substance is seldom affected. In cases of cerebral œdema, however, the cut surface may present a yellow color. In obstructive jaundice the larger bile ducts, the hepatic, cystic, and common choledochus, as well as the gall bladder, become distended. The ducts outside of the liver are found elongated and curved upon themselves. In the liver substance localized distentions are found which sometimes appear near the surface in the form of cysts. These dilated vessels are at first filled with bile, but if the obstruction exists for a length of time, the biliary matter gradually disappears and the gall bladder and ducts are then distended with mucus.

The liver, which at first is increased in size, afterward becomes atrophied. The color in the early stage is intensely saffron yellow, but it afterward changes to a green or greenish black. Upon microscopical examination the cells around the central vein are diffusely stained yellow, while those nearer the periphery contain numerous pigment granules. The latter predominate in the older cases. In some instances the connective tissue between the cells proliferates to a considerable extent, and one form of cirrhosis is thus produced. The smaller biliary radicles are filled with bile, and the cylindrical celled epithelium lining the walls becomes changed to the pavement form. Vaughan Harley in his study of the condition of the liver in obstructive jaundice speaks of the compressed and atrophied appearances of the hepatic cells, similar to what is found in nutmeg liver. He found the cells separated and compressed by dilated lymphatics, due to backward pressure.

Next to the liver, the kidneys undergo the greatest changes. They present externally a greenish color, while the cut surface is of a saffron yellow. According to Frerichs, in chronic cases the kidneys assume a dark olive green color. Stripes of green are often found in the pyramids. The epithelium of the tubes is stained yellow, while that of the Malpighian bodies is often not much affected. A slight desquamative nephritis is often produced by the irritative quality of the bile. This is shown by the presence of casts in the urine. Bile circulating in the blood is a cause of anæmia, and as a result the muscles, especially the muscular fibres of the heart, undergo degeneration. Cardiac dilatation consequently is frequently found in jaundice.

Icterus Neonatorum.

This condition, which so often occurs in newly-born children, is usually explained as follows: Previous to birth the blood of the portal system containing bile pigment absorbed from the intestine passes partly through the liver and partly through the ductus Arantii into the inferior vena cava. Jaundice does not occur, on account of the bile being secreted in such small quantities. After birth the amount of bile is very much increased, and if the ductus venosus still remains patent, a sufficient amount of pigment may pass into the general circulation to produce jaundice. This explanation has been given by Quincke, but the theory has not been confirmed by post-mortem examination.

Another explanation is that a thickened condition of the bile may produce obstruction.

In some cases, especially in prematurely born children, the deficiency of the respiratory movements and the weakness of the heart's action may so interfere with the hepatic circulation as to produce jaundice.

A fatal form of jaundice occurs in newly-born children as the result of permanent occlusion of the common bile duct. It is also present in infants in cases of pylephlebitis from infective inflammation of the umbilical veins. Jaundice also occurs in cases of starvation.

Symptoms of Jaundice.—The most striking symptoms of jaundice are the discoloration of the skin, the dark-colored urine, and the absence of coloring matter in the fæces.

Skin.—The discoloration varies in intensity in proportion to the amount of obstruction. It may be light yellow, light saffron, or greenish yellow to almost black. The discoloration is often not noticed earlier than three days after the obstruction, and is first seen in the conjunctiva and parts of the integument which are thin and richly supplied with bloodvessels. The staining is not always confined to the integument, but is also found in the mucous membrane of the mouth and throat. Staining of the perspiration is sometimes shown by the clothing. Pneumonic sputum has been found stained with bile. Tears, saliva, and mucus are usually not stained. Besides the discoloration of the skin, the bile produces some characteristic eruptions, among the most frequent of which are erythema and urticaria. Furunculi are often present, and exanthelasma appears on the eyelids and face. The latter is a condition of the skin met with in chronic jaundice in which slightly raised growths of a yellow color with flattened surfaces appear on different parts of the body, but most frequently on the eyelids. They are of a pseudo-glandular structure. Pruritus is a very troublesome symptom which often exists previous to the discoloration of the skin, and sometimes remains after the latter has passed away. Harley was of the opinion that the principal agents in its production were the biliary salts. Hyperidrosis localized to certain parts of the body, principally the abdomen and palms of the hands, has frequently been noted. Hemorrhages beneath the skin and mucous membrane are found in the more severe cases.

Urine.—The color of the urine varies from greenish yellow to dark brown according to the amount of bile pigment present. The specific gravity ranges between 1020 and 1025. The color is very often seen in

the foam, and may be detected by its staining white paper or white underclothing. Its presence is shown by Gmelin's test, which may be made by dropping the urine and fuming nitric acid near together on a porcelain capsule, and observing the play of colors when the acid and urine come in contact with each other. Another way is to introduce into a test tube some nitric acid, and upon this to gently float a column of urine. In the zone between the urine and acid the following colors appear from below upward : green, blue, violet, red, and yellow. The green is most distinct, while blue is sometimes absent. When the urine is deeply stained it is necessary to dilute it (Purdy).

Pettenkofer's test for biliary salts may be made as follows : The urine is mixed with a trace of concentrated sulphuric acid, and a 10 per cent. solution of cane sugar added drop by drop, at the same time stirring with a glass rod. A purplish red color indicates the presence of biliary acids. If the solution be heated above 50° C., the test is likely to fail. Another method is to shake the urine with the syrup, and after a froth has formed to allow the acid to flow down the side of the tube. The froth presents a delicate purple color (Hamilton). The biliary acids are often absent when pigment is present. The frequent absence of the biliary acids from the urine is accounted for on the ground that they are transformed in the blood into other compounds. The urine in jaundice often contains a large amount of urates and is deficient in urea. Albumin in small quantities and casts of different varieties are often found. In some cases of obstructive jaundice " sausage-shaped plugs " from a gray green to an almost black color, loosely packed together in masses which resist the action of reagents, are found in the urine. It is necessary to exclude the discoloration of the urine due to rhubarb, chrysophanic acid, and santonin.

Digestive System.—The tongue is often coated with a yellowish fur, and the mouth more or less filled with a sticky mucus. The breath is fetid, and a bitter taste is experienced in the mouth. Loss of appetite and nausea after taking food, followed sometimes by vomiting, occur. In a few cases the appetite is increased. The stomach is frequently distended with gas, and the gastric juice contains a lessened amount of free hydrochloric acid. The bowels are distended, and there is a strong tendency to constipation. The fecal discharges have a disagreeable odor of putrefaction. They are either clay-colored or variegated, a part retaining the normal appearance and a part of a whitish color. The normal coloring matter of the fæces is probably a hydrobilirubin, allied to urobilin, one of the pigments of the urine. This is derived from the bile. The putrid odor in jaundice is due to the absence of bile, an antiseptic agent, and to the decomposition of fats. The fæces are often colored accidentally by medicines, such as iron, mercury, and bismuth. When urine is present in the same vessel the external surface of the fecal matter may be stained yellow. On account of the absence of bile in the intestines fatty matter which should have undergone saponification is found free in the fæces. The fat may form from 52 to 78 per cent. of the whole mass, whereas in normal conditions it should not form more than from 6 to 10 per cent. It is found in the form of plates or circular crystals, as shown by Nothnagel and Gerhardt. Pressure on the pancreatic duct, coincident with that of the common bile duct, will

in some cases account for the large amount of unchanged fat in the fæces.

In normal digestion the bile arrests peptic action, but when the bile is absent this peptic action continues and neutralizes the action of the pancreatic juice, so that even in cases where the latter flows freely into the intestine it may not have its normal effects upon the intestinal contents.

The liver is enlarged and tender, and more or less pain may be experienced over the abdomen, depending on the cause of the obstruction. The glycogenic function is to some extent interfered with, and to this is ascribed by some the lowering of the temperature of the body.

Circulatory System.—The first sound of the heart is often weakened, and a systolic bruit, probably due to anæmia, may be developed. Potain thinks that the cardiac bruit is due to a mild myocarditis resulting from jaundice. The pulse may be increased in force and is often diminished in frequency. The writer has observed cases in which the frequency was not over 40 to the minute. Frerichs has recorded a case in which the heart beats were as low as 21 to the minute. According to Strümpell, the taurocholate of soda is the ingredient which acts on the cardiac centres.

Enlargement of the spleen often occurs as the result of septic processes or obstruction to the portal circulation—conditions which may exist along with jaundice. The flow of blood through the lungs seems to be obstructed, as the pulmonary second sound is often accentuated, and slight œdema of the limbs has been pointed out by G. DeMussey.

Nervous System.—Xanthopsia is a somewhat rare symptom, and in most cases can only be explained as a purely nervous phenomenon. Night-blindness has also been noticed. A few cases have been reported in which patients have had better sight in the twilight than in bright daylight. Headache, dulness of intellect, and despondency are frequent symptoms. More or less general disturbance of the nervous system, such as restlessness, delirium, or drowsiness, is present in severe cases. In the later stages lethargy, Cheyne-Stokes respiration, slow pulse, and coma precede a fatal result. Some have ascribed the nervous symptoms of jaundice to the presence of cholesterin in the blood, others to the biliary salts. Bouchard considers the coloring matter much more poisonous than any other ingredient. In obstructive jaundice death is more often the result of the condition which caused the jaundice.

In pregnant women the fœtus may become jaundiced if the condition lasts long enough in the mother. In 2 cases, 1 of which lasted five and the other fourteen days, Frerichs did not find staining of the fœtus.

The COURSE and DURATION of jaundice depend upon the cause. In the catarrhal form the obstruction usually yields in a few days, and the bile flows through the natural channels into the bowels. In such cases the icteric tint passes away rapidly, and the digestive functions are restored in a few days. When the obstruction is complete, and especially if the kidneys do not perform their functions properly, grave symptoms of cholæmia may supervene, such as hemorrhage, together with the nervous symptoms already described. To these may be added change of voice, sleeplessness, and rapid emaciation.

The causes of death in jaundice may be classified as follows: 1.

Those affecting the nervous system—delirium, convulsions, and coma; 2. Asthenia in the so-called typhoid condition; 3. Hemorrhages.

When the obstruction is incomplete or when the kidneys and skin perform their functions well, a patient may remain jaundiced for months without serious symptoms arising. The course in many cases depends on the previous condition of the patient. Frequently the primary disease—carcinoma, for instance—has sapped the vitality before the onset of the jaundice. In the non-obstructive forms the symptoms are much more modified by previous disease; for instance, by the specific fevers or the ingestion of poisons.

Diagnosis.—In daylight the color of jaundice is easily recognized, but it may be overlooked in artificial light. The conditions with which it may be confounded are arsenical cachexia, morbus Addisonii, and congenital condition of yellow skin, which may become more intense when exposed to the sun's rays. In all these cases, however, the bile pigment is present in the stools and absent in the urine, and in the majority the conjunctiva is not stained as in jaundice. The dark-colored patches seen on the surface of the tongue and buccal mucous membrane in morbus Addisonii are not found in jaundice. A condition of sallowness, with more or less discoloration of the conjunctiva, should not be mistaken for jaundice. In such cases there may be a high-colored urine, but the excessive pigmentation is not due to the presence of bilirubin. This condition has been termed urobilin jaundice, but it is really distinct from true jaundice.

The diagnosis of the various causes of jaundice is much more difficult, and will be discussed farther on. It is in many cases not easy to determine whether it arises from some cause outside the liver or from a changed condition of the parenchyma itself. The past history and the mode of onset may be of service. In the intra-hepatic form the jaundice is often not so intense; the amount of bile pigment in the urine may be slight or it may be absent. The fæces may present more or less the normal color. When, however, there is marked degeneration of the hepatic cells the jaundice is as intense as in the extra-hepatic form.

Treatment.—In all cases of obstructive icterus the primary disease must, if possible, be discovered and appropriate treatment adopted. We have, however, many cases, particularly those of the catarrhal variety, in which the jaundice is almost the sole condition, and others, again, in which the primary disease can only be made out after long investigation. In both cases symptomatic treatment is at first necessary. That form of diet which will irritate the liver as little as possible should be prescribed. Milk is perhaps the best, as it possesses diuretic properties which assist the kidneys in the elimination of bile. Meat broths, well-cooked fruit, and soft-boiled eggs with a very moderate amount of farinaceous food may be given. Alcohol and fatty foods of all kinds should be interdicted. Thirst may be quenched by cold water, lemonade without sugar, Appolinaris, Giesshübler, etc.

The medicinal remedies found to be of service are nitro-muriatic acid, salol, salicylate of soda, calomel, benzoic acid, and benzoate of soda. For the bitter taste in the mouth and coated tongue Eichhorst recommends dilute hydrochloric acid. For the constipation a dose of

calomel may be given, followed by such laxatives as taraxacum, rhubarb, senna, or cascara sagrada. Phosphate of soda is of great value in catarrhal jaundice. Hepatic stimulants, as euonymin, podophyllin, jalap, and colocynth, are of service in some cases. These remedies probably act as purgatives, and by increasing the flow of bile may dislodge the mucus which obstructs the common bile duct.

Salol and salicylate of soda are given on account of their antiseptic action on the contents of the gastro-intestinal canal, as well as their property of increasing the flow of bile and rendering it more liquid. Inspissated ox gall has also been given as a purgative and antiseptic. The fresh ox gall is frequently administered in the form of an enema.

The lessened amount of urine and the diminished secretion of urea deserve attention. Diuretics, as the acetate, bitartrate, and nitrate of potash, have been recommended. Bouchard is more cautious in giving the potash compounds, as he is of the opinion that the most virulent poisons found in the blood in cases of auto-intoxication contain potash. Mineral waters have had for many years a reputation for the cure of jaundice. Those of alkaline character possessing purgative properties, such as Carlsbad, have been used. Patients of full habit take Marienbad, Vichy, Kissingen, and Homburg waters, while those who are depleted take Carlsbad with advantage. Vichy has a special reputation among French physicians. Ems and Selters have also been much used. Hathorn Saratoga water is recommended by Tyson.

The pruritus, often the most prominent and most disagreeable symptom, cannot be permanently relieved except by the cure of the jaundice. Harley has recommended iodide of potassium, and Eichhorst bromide of potassium in 30-grain doses, morning and evening. Warm baths and lotions containing carbolic acid, vinegar, or bicarbonate of potassium are sometimes serviceable. Perhaps the most relief is obtained from hot baths containing soda. Insomnia is often troublesome, and is best treated with chloral and sulfonal. In some cases pain in the hepatic region may be so great as to require morphine and other sedatives. When the symptoms of cholæmia present themselves various methods of elimination should be more actively employed. Besides these camphor and benzoic acid have been recommended by Eichhorst.

Bouchard's method of giving large enemata of hot water may be adopted to increase the flow of urine. This method of treatment, which the writer has found to give excellent results in cases of threatened uræmia, ought to be of value in cholæmia.

Abnormal Conditions of the Bile.—The great difficulties which have surrounded the investigations into the character of the bile in disease have prevented the pathologist from obtaining the same accurate knowledge of its composition as in the case of the urine. However, by experimentation and by careful observation of patients in whom biliary fistulæ exist as the result of operation investigators have been enabled latterly to obtain a much more correct idea of the composition of this fluid. The following account of the abnormal conditions are taken largely from Gamgee.[1]

Hæmoglobinocholia has been found present in bile in animals poisoned by certain substances, as phenylhydrazin, toludendiamin, the

[1] Gamgee: vol. ii. p. 357, *Chemistry of Digestion.*

derivatives of aniline, pyrogallol, chlorate of potassium, etc. It may exist in pernicious anæmia and in the early stages of acute yellow atrophy.

In the passive congestion of the liver albumin has occasionally been found, as well as in Bright's disease. When water is injected into the veins of animals albumin is found in the bile. The bile is said to contain a large quantity of sugar in diabetes, and Claude Bernard found sugar present in the bile of animals when it was injected into their veins. An excessive quantity of urea exists in the bile in Bright's disease and cholera. Leucin and tyrosin are found in cases of acute yellow atrophy.

The coloring matter of the bile is most diminished in fatty liver. Noel Paton and Balfour found in a case of biliary fistula that the bile was always paler during the pyrexia, and that in an attack of tonsillitis it became quite destitute of color and the quantity secreted was much less.

Urobilin Jaundice.—Cases of discoloration of the skin not infrequently exist in which the bile pigment cannot be detected in the urine by Gmelin's test. Some of these are explained by the fact that the coloring matter remains in the skin some time after it has been eliminated from the blood. There are also cases of continued pigmentation in which biliverdin is not found at any time in the urine. Quincke explains these cases by the fact that biliverdin becomes transformed in the urine into urobilin, and that the former is always found in the blood serum. The discoloration in jaundice is not due to urobilin, which does not possess the property of staining the tissues (Gamgee).

CHOLANGITIS AND CHOLECYSTITIS.

THE hepatic lobule as it has usually been described is surrounded by branches of the bile duct and portal vein with their connective tissue, and has in its centre the hepatic vein. It has, however, been demonstrated by Sabourin and others that the liver is essentially an acinous gland, and that it should be described as such. Its excretory duct and accompanying bloodvessel should form the stem around which the tubules with their cells are constructed. The hepatic vein with its radicle, instead of being central, would then be considered as peripheral in character, and the bile duct and portal vein would occupy the centre of the billary lobule as it has been described by Sabourin. To obtain a true conception of the structure of the liver one should consider three or four vascular lobules together. The hepatic duct and portal vein with their connective tissue would form the centre of a portion which would be made up of segments of the surrounding vascular lobules. The secreting portion of the liver is then made up of an aggregation of biliary capillaries enclosing individual hepatic cells (Hamilton). These capillaries communicate directly with the bile ducts, which converge to form the hepatic and common choledoch ducts. The latter is furnished with a reservoir, the gall bladder. All inflammatory conditions found between the cells and the duodenum may be included under

the terms cholangitis and cholecystitis. In some cases the source of irritation may be in the hepatic cells, and the inflammation passes from above downward, such, for instance, as occurs in phosphorus-poisoning. In the majority of cases the irritant passes from the duodenum to the common bile duct, so that the inflammation extends from below upward.

Cholangitis and cholecystitis may be of two varieties, the (1) catarrhal and the (2) suppurative.

(1) Catarrhal Cholangitis.

Etiology.—Primary catarrh of the biliary passages occurs from time to time as the result of chills, but it is, as a rule, secondary to other conditions. Jaundice frequently follows exposure to cold without pre-existing symptoms of gastro-duodenitis. Such forms of catarrhal icterus are more frequent in the spring and fall.

In the great majority of cases the inflammation begins in the gastro-duodenal mucous membrane, and extends into the common bile duct. Frerichs in 41 cases discovered premonitory symptoms of gastro-enteric catarrh in 34. The ingestion of too large a meal, of too much fat or other indigestible food, of too hot or too cold drinks, particularly when taken to excess,—all may act indirectly in the causation of catarrhal icterus.

Acid substances and strong alcoholic drinks frequently act as irritants to the mucous membrane of the stomach and bowels. Catarrh of the biliary passages often occurs in patients who are the subjects of gout.

Among other causes may be mentioned the mechanical irritation produced by calculi or by an aggregation of parasites, diseased conditions of the hepatic parenchyma, cancer, echinococci, abscess and interstitial inflammation, derangements of circulation, active and passive congestion, the latter resulting from cardiac and pulmonary disease. Chemical changes in the bile itself are sometimes a cause of inflammation, especially when it remains stagnant for a long time in the gall bladder and ducts.

Senator has described a menstrual jaundice in which a slight catarrh occurs during the menstrual period. The condition of the biliary passages in cases of jaundice from sudden alarm or fear is not known. Some are of the opinion that in these cases there is a catarrhal inflammation, while others think with Potain that a spasm takes place, giving it the name of spasmodic jaundice.

Phosphorus and lead in poisonous doses produce a catarrhal inflammation, as well as the infectious diseases, pneumonia, typhoid, malaria, and in some cases syphilis in its secondary stage.

In epidemic jaundice the poison introduced into the system by the drinking water produces catarrh of the bile ducts.

Catarrhal cholangitis is found equally in both sexes. It does not often occur in old age.

Intermittent fever is a frequent cause of catarrh of the biliary passages in those living in malarial districts.

In the milder forms of endemic catarrhal icterus miasmatic influences are often the cause. It has occurred after the opening of

sewers or the digging of trenches. In such epidemics individuals of both sexes and of all ages suffer equally. House epidemics have been reported. Seitzer described one in which 14 persons were affected, the result, he thought, of decomposing matter which had escaped from the drain pipe into the kitchen. Epidemics of catarrhal jaundice have occurred frequently in garrisons.

Pathological Anatomy.—The inflamed passages are dilated, the mucous membrane is thickened and of a deep red color. The canal contains a thick, tough mucus which obstructs the bile. This is made up of mucin, leucocytes, and epithelial cells. In some cases by squeezing the divided ends of the common bile duct a plug of mucus may become dislodged. These changes are more frequently found in the ductus communis choledochus, near the duodenal extremity. They do not often exist in the hepatic duct. When the disease passes off the ducts and surrounding tissues, as a rule, resume their normal condition. In a few cases of severe inflammation the wall remains thickened and the lumen contracted. Narrowing and complete occlusion have occurred in this way. The obstruction thus produced may terminate in the formation of calculi and in permanent dilatation of the bile ducts above the seat of stenosis. There is frequently an increase in the size of the liver from hyperæmia.

Symptoms.—The symptoms of catarrhal jaundice may be considered under three heads: (1) premonitory, (2) local, and (3) those of obstructive jaundice.

The premonitory symptoms of gastro-duodenal catarrh occur in a large proportion of cases. They may extend over a period of one or two weeks, or they may be so slight and of such short duration that they are not noticed. The patient may complain of headache, vertigo, slight chilly sensations, and a feeling of fulness in the region of the stomach, as well as of general malaise. The temperature may be slightly elevated and the pulse somewhat more rapid. The tongue is coated and the breath has a fetid odor. The patient complains of a bitter taste in the mouth, of loss of appetite and nausea, which may be followed by vomiting. After a varying length of time a slight yellow tinge is noticed in the conjunctiva. The skin becomes gradually discolored until the whole surface of the body is jaundiced. The pulse, which in the early stages is increased in frequency, becomes slower than normal, often under 60 beats to the minute. The patient is irritable and morose, and suffers sometimes from intense pruritus. The urine is deeply stained with bile pigment and the fæces are clay colored. In fact, the symptoms of obstructive jaundice which have been described in a former article may be present. During this stage the liver is enlarged and more or less tender. The gall bladder may be distended, and felt as an elastic tumor at the outer margin of the right rectus. Sometimes the patient suffers from darting pains as well as from a feeling of distention in the region of the liver. In most cases the onset of jaundice is followed by a decline in the gastric symptoms.

The duration of the disease is from two to three weeks, and it nearly always terminates in recovery in uncomplicated cases. The catarrhal condition may result in the formation of gall stones, or these may be present previous to the attack. In both cases recovery will be

delayed. In cases of severe inflammation a stricture may be formed and permanent obstruction to the flow of bile supervene.

Diagnosis.—The diagnosis of catarrhal inflammation of the biliary passages is usually easy after the appearance of jaundice. The presence of the symptoms of gastro-duodenal catarrh is a very important point. In some cases it is extremely difficult to exclude pre-existing disease of the liver. The writer had under observation at the same time two cases of jaundice, in both of which the onset was comparatively sudden and apparently very similar. In neither of them were there any symptoms of pre-existing disease. In one case recovery took place in about three weeks, while in the other the jaundice became permanent and a fatal result ensued. In the latter a small circumscribed adenomatous tumor was found in the wall of the duodenum, blocking up the common bile duct at its entrance. It is often difficult to differentiate from the obstructive jaundice produced by gall stones. The severe pain of biliary colic, as well as the many other symptoms arising from the presence of gall stones, will aid in the diagnosis.

It must be here remembered that jaundice often accompanies various forms of inflammation of the liver, carcinoma, and other grave diseases. These can be sometimes excluded by the previous history and by physical examination. The same may be said of tumors which cause pressure on the common bile duct.

Treatment.—Our efforts should be directed first to the relief of the gastric and duodenal symptoms. The diet should be simple and of a fluid character, such as thin, clear soups, milk, and a limited amount of farinaceous food. Milk to which lime water may be added should be given for the first few days, to be followed by the other articles mentioned. Meats, fish, and eggs may be given toward the end of the attack in limited quantities. Alcohol, fats, and oils are forbidden. If dyspeptic symptoms are present, an emetic may be administered. This has the effect of not only emptying the stomach, but at the same time of producing relaxation of the common bile duct and the expulsion of mucus. A dose of calomel of 5 or 10 grains will cause contraction of the gall bladder. Blue pill is sometimes given at night, followed by a saline in the morning. Salicylate of soda and salol, while acting as antiseptics, are also of special value in increasing and liquefying the bile. Phosphate of sodium in drachm doses may be given for the constipation. Bartholow has recommended sulphate of magnesium in gouty subjects, to which in cases of anæmia and debility quinine and sulphate of iron may be added. He also recommends the permanganate of potassium in tablet form three or four times a day. Nitro-muriatic and nitric acid have long been used for catarrhal jaundice. They prevent fermentation, and the hydrochloric acid may aid the digestion. These acids are supposed by their irritant action on the mucous membrane of the stomach and duodenum to cause contraction of the gall bladder and a more thorough emptying of the bile ducts.

Alkalies, especially those of the mineral waters, Carlsbad, act by increasing the amount of bile excreted.

Krull recommended the injection of a large quantity of water into the bowels, which was retained as long as possible to allow absorption to take place. These enemata may act by stimulating the peristalsis,

as well as by increasing the amount of liquid to be excreted by the liver. His plan, as given by Schüppel, was as follows: The patient slowly receives by means of a fountain syringe an enema of cold water, one to two litres, at a temperature of 60° F., once each day, which is retained as long as possible. The temperature of the water after a time is raised to 72°, when injections are repeated. They are given once daily. A marked effect of this treatment seems to have been the rapid subsidence of the gastro-duodenal symptoms. Mosler recommends an enema of a half a litre of warm water given three times a day. Gerhardt has recommended compression and faradization of the gall bladder to remove the plug of mucus which often causes the obstruction. The emptying of the viscus by manipulation can only be accomplished when it can be felt beneath the abdominal walls. It is then grasped by the fingers and pressed against the vertebral column. As Schüppel pointed out, this treatment in many cases cannot be adopted on account of the great tenderness of the hypochondrium. It is also not free from danger, especially in old cases, where, owing to ulceration, the walls of the biliary passages may in some places be very thin.

In addition to those already given, some recommend as intestinal disinfectants bismuth salicylate, β-naphthol, benzo-naphthol, and chloroform water. Resorcin with strychnine is also recommended.

The function of the liver as a guard against poison is to some extent weakened in catarrhal jaundice. The allowance, therefore, of meats, egg albumen, saccharine and starchy food should be carefully estimated in each case.

(2) Suppurative Cholangitis.

Bacteria are found in the normal state in that portion of the ductus communis choledochus which is close to the duodenum. The bacillus coli communis and the staphylococcus aureus often exist in that situation. The duodenum, however, is the normal habitat of a variety of germs, among others the coli communis, streptococcus, and staphylococcus. In diseased conditions the pneumococcus and typhoid bacillus have also been found in that portion of the small intestine. Under certain circumstances these bacteria may pass into the biliary ducts, thus setting up a purulent inflammation. It has been proven experimentally that suppurative cholangitis can be brought about in this way. The bacterium coli communis seems to play the most important part in such infective inflammations. It is probable that in some cases the germs may reach the liver through the bloodvessels and thus set up a cholangitis. An obstruction in the biliary passages predisposes to suppurative inflammation, and frequently a simple catarrhal condition becomes purulent after the invasion of pus organisms. The bile ducts may also become infected in pylephlebitis and in abscess of the liver.

Suppurative cholangitis is frequently found among gouty people and those who have had syphilis, but the great majority of cases occur in those who have suffered from biliary calculi or when other foreign bodies have found their way into the passages. The inflammation may begin as a catarrh and suppuration follow after a time. Infective diseases, as

typhoid fever, are sometimes complicated by a suppurative cholangitis, often due to the presence of infective germs. Gangrene and ulceration may supervene. When the biliary ducts are partially occluded by pressure from without, a tendency to the development of suppurative cholangitis exists. In some cases the suppurative inflammation may extend from a previously existing hepatic abscess. This form of disease occurs mostly in adult life, because biliary calculi, which are so frequently the predisposing cause, are developed during that period.

Pathological Anatomy.—Suppurative inflammation may be limited to the gall bladder, to the hepatic and common bile ducts, and to the intra-hepatic ducts, or the whole system may be affected. Within the liver the disease may terminate in the following forms: (*a*) Disseminated miliary abscess, the result of pericholangitis; (*b*) multiple abscess, in which there is a direct communication with the bile ducts; (*c*) solitary abscess made up of the aggregation of a number of small purulent formations.

In suppurative inflammation of the bile ducts they are dilated and usually filled with mucus mixed with pus and bile, the latter giving the contents a greenish color. The connective tissue may be inflamed and infiltrated with pus, and this may extend to the portal vein, causing a portal phlebitis.

Ulcers may result from the presence of gall stones, or more rarely from typhoid poison. The walls of the bile ducts are thickened and the lining membrane is soft and swollen.

In the liver itself the purulent contents often perforate the fine walls and pass into the substance of the organ. Small abscesses are thus found which after a time have a lining membrane, forming cavities which communicate freely with the biliary ducts. These sometimes coalesce and form a large accumulation of pus resembling to some extent the tropical abscess.

In some cases miliary abscesses may result from a suppurative pericholangitis which does not communicate with the duct. These conditions may be complicated by symptoms of general septicæmia, in which vegetative endocarditis may exist as a primary or a secondary condition.

Suppurative inflammation of the gall bladder occurs usually in connection with obstruction by gall stones. The viscus may become enormously distended and changed into a pus cavity, empyema of the gall bladder, the form of which in some cases may be easily mapped out through the walls of the abdomen. It contains bile, mucus, and pus with gall stones. The inner surface of the gall bladder is swollen, thick, and congested. The mucous membrane may be of a reddish or grayish color and present pigmentary spots. It is sometimes deeply stained. Ulcers are frequently found near the fundus, and gall stones often occupy the same position. Ulcers of the gall bladder occasionally result from the presence of foreign bodies and from typhoid fever. Suppurative and ulcerative cholecystitis, together with the intestinal lesions of typhoid fever, were found in a post-mortem examination at the Toronto General Hospital in a case where typhoid fever had been diagnosed during life. Occasionally, as in a case which came under my observation some years ago, the mucous membrane is entirely

separated from the wall of the gall bladder by suppurative inflammation.

Gangrene is not an infrequent complication of ulcers, and perforation takes place in this way.

Von Schüppel describes a form of ulcer of the gall bladder which resembles in its formation that of gastric ulcer, and which he supposes is partly caused by the irritation of bile in an abnormal condition.

A long-continued catarrhal inflammation of the gall bladder results in a thickening of the connective tissue of the walls and adhesions to the surrounding parts. The gall bladder in this way becomes contracted, and its cavity may be very small and narrow. It may then resemble a tube having dense walls which is filled with tough mucus.

Symptoms.—Suppurative cholangitis may run its course without any symptoms sufficiently definite to denote its presence. This is especially the case in the infectious diseases, when the symptoms of the latter may be so pronounced as to entirely mask the condition of the biliary passages. We will first describe the symptoms in connection with the liver itself, and then those of a constitutional character.

The liver becomes enlarged and tender, and a feeling of tightness and distention is experienced in the right hypochondrium. Jaundice occurs in all cases where there is biliary obstruction, but this is not so marked or so constant a symptom as in the catarrhal form of inflammation. When the jaundice is persistent it is not so intense as in the catarrhal variety. In the early stages the general symptoms of gastro-duodenal catarrh, loss of appetite, nausea, and vomiting, may be present. These are followed by fever, which may be intermittent or remittent in type. The exacerbations are preceded by rigors more or less prolonged, in which the temperature may rise to 104° or 105° F., and which are not influenced by quinine. When gall stones are present the rigors may be accompanied by pain, which is often very severe. In the later stages, in some cases, the symptoms may be quite similar to those of general pyæmia, and the disease may terminate fatally in a few days or in a few weeks. In other cases the obstruction may be overcome and the passages become emptied of pus, recovery taking place. Febrile symptoms are not always present, especially when there is gangrene of the walls of the gall bladder.

In cases of suppurative cholecystitis, general pyæmia or rupture of the gall bladder into the abdominal cavity may lead to a fatal result. When rupture has not taken place the contents may be evacuated by operation and recovery take place.

Suppurative cholangitis is usually an acute disease, not lasting longer than two or three weeks. In some cases it pursues a chronic course and may last many months. Budd was of the opinion that many of these cases recover. A fatal result is probably the rule in cases not operated on when the symptoms are sufficiently definite to make a diagnosis.

Treatment.—The most important point in the treatment of suppurative cholangitis is, if possible, to discover and remove the cause of obstruction. The usual management of suppurative fever, which consists of general support and attention to the elimination of poisonous matter, should be adopted. The early diagnosis of pus in the gall

bladder is a matter of importance, as its evacuation has been successfully accomplished in cases which otherwise would have resulted fatally.

When symptoms of peritonitis supervene the patient should be kept absolutely quiet and warm poultices applied to the region of the gall bladder. Opium may be given if the pain is severe, and salines sufficient to keep the bowels regular. The patient's strength should be supported. A diet nourishing and not stimulating should be adopted. Quinine and bitter tonics are often of service.

DISEASES IN WHICH THE HEPATIC CELL IS PRINCIPALLY AFFECTED.

Changes in hepatic cells may be temporary or permanent. Under normal conditions changes occur at different periods of the digestive process, and it is probable that modifications of structure take place to an even greater extent in many diseased conditions which have not yet been sufficiently studied. A number of these modifications of cell structure are present in jaundice both malignant and benign. Pathological conditions affecting the hepatic cells may be described, as has been done by Chauffard, under the following heads:

1. Phosphorus-poisoning.
2. Syphilis.
3. Alcohol.
4. Toxins of infectious diseases.
5. Epidemic jaundice.
6. Acute yellow atrophy.
7. Poisoned food (this has been described under Food-poisoning, by Victor C. Vaughan, p. 359).
8. Weil's disease (this has been described in Vol. I. pp. 945, 946).

1. Phosphorus-poisoning.

The changes in the liver in phosphorus-poisoning are so marked, and they throw so much light on other pathological conditions, that a special reference to them is necessary.

When phosphorus is taken into the system the hepatic symptoms do not come on at once. In from three to twelve hours after its ingestion a sense of weakness and general malaise is manifested, which in some cases is followed by vomiting and pain. The latter, as a rule, is not severe. The vomited matter consists at first of food, mucus, and bile. A smell of phosphorus is noticed, and the stomach contents are often luminous in the dark. Afterward blood acted on by the gastric juice may give the appearance of coffee-grounds. The temperature may be slightly elevated in the early stages, but shortly before death it falls rapidly. The passages from the bowels may be normal or watery at first, but are afterward light, clay colored, and may contain blood. Jaundice comes on in from thirty-six hours to four days, but it may appear later. Bamberger has shown that it may not supervene until

the second or third week after the taking of the poison. In the only case observed by the writer jaundice was delayed until the sixth day. It is first noticed in the conjunctivæ and urine. The liver is markedly increased in size at first, but atrophy afterward takes place to a sufficient extent to be appreciated by percussion. The urine is scanty, containing albumin, bile pigment, bile acids, sugar, leucin, tyrosin, and sarcolactic acid. Fat has been found in the desquamated epithelium and in free globules. The blood is dark in color and loses its power of coagulation. Hæmatin is separated from the corpuscles and is sometimes found in crystals. Extravasations may occur in any part of the body, but are mostly found in the mediastinum and serous membranes.

In those cases which survive the first few days symptoms of interstitial hepatitis are developed—*i. e.* pain in the region of the liver with rise of temperature and general febrile disturbance.

Pathological Anatomy.—The liver at first is very considerably enlarged, and the margin is thick and round. The color is pale or yellowish white if the fatty degeneration is more intense. Occasionally the light color is marked at the periphery of the lobules, and the centre is dark red from congestion. Sometimes the whole organ is intensely congested. Extravasations of blood are noticed in different parts, and the parenchyma is often more affected in one part of the organ than in another. The consistence depends on the amount of fatty degeneration, and is usually much softer than normal. The weight is increased at first, but not to any great extent.

Microscopical Appearances.—The hepatic cells in the early stages are enlarged and the contents are cloudy and granular (cloudy swelling). Small drops of fat are seen surrounding the nucleus. These increase in size and coalesce, forming larger drops, but they never become so large as to occupy the whole cell, as in the ordinary fatty infiltration. The increase in volume of the cells produces partial obstruction of the bile ducts, and these are at the same time directly affected by the poison, a cholangitis being the result. The capillaries are also subject to pressure, with consequent anæmia of the liver. The flow of bile is modified in the earlier stages, and as the process goes on the obstruction is more marked. Jaundice, which was slight at first, becomes increased in intensity.

The destruction of the hepatic cells, together with the accompanying anæmia, causes a diminution in glandular action. The bile is secreted in less quantity, the glycogenic function is imperfectly carried on, and the formation of urea is interrupted. On account of the latter, leucin and tyrosin are found in the liver substance and in the urine.

In the more chronic cases some of the affected cells become absorbed and others return to a healthy condition; the liver becomes smaller and its function may to some extent be restored. The connective tissue is in many cases affected: first an infiltration of round cells takes place, and then an increase in fibres—a true cirrhosis. The inflammation of the interstitial tissue commences after the changes just described in the hepatic cells.

In a few cases death takes place before the liver has undergone much change. In one which proved fatal in nine and a half hours after the poison was taken the liver was enlarged and much congested,

but the parenchyma was not much changed. Cloudy swelling and fatty degeneration of the cells occur quite early—in from twelve to twenty-four hours, as has been shown by experiments on animals—and cell infiltration of the connective tissue has been noted in five days.

Course and Duration.—The rapidity of the development of the symptoms after the ingestion of phosphorus depends upon the form in which the drug is taken. Signs of local irritation may be manifested within an hour or two after it has been swallowed in a soluble form, as in phosphorated oil, whereas the symptoms may be delayed from six to ten hours after it has been taken in the solid form.

About one fourth of the reported cases of phosphorus-poisoning have recovered. The prognosis is more favorable if proper treatment is adopted early and the poison is removed from the stomach. After jaundice and hemorrhage supervene the prospect for recovery is very slight.

Diagnosis.—The condition of the liver in phosphorus-poisoning differs from that of acute yellow atrophy in two important particulars: In the latter the atrophy takes place early, and is more marked and the fatty degeneration is much less prominent. In post-mortem examinations the liver in phosphorus-poisoning is usually larger than normal, whereas in acute yellow atrophy it is smaller.

The differentiation between these two conditions is often very difficult. The presence of phosphorus in the vomited matter and stools is a direct evidence of poisoning by this drug. When death occurs during the first week the increase in the size of the liver would exclude acute yellow atrophy, but in the second week the atrophy which in phosphorus-poisoning follows hypertrophy might lead to error. The presence of sarcolactic acid in the urine is said to be distinctive of the latter condition. According to Thierfelder, in acute phosphorus-poisoning there is a well-marked remission before the appearance of the final symptoms, which is absent in acute yellow atrophy. In phosphorus-poisoning grave symptoms appear with the jaundice, whereas in acute yellow atrophy such symptoms do not present themselves until two or three days after the onset of jaundice.

Treatment.—The changes produced by phosphorus on the hepatic cells are of such an intense character that every effort should be made to prevent absorption. The stomach should be emptied by the pump or by emetics as soon as possible. Fats and oils should be excluded from all foods and medicines, as they dissolve the drug. H. C. Wood recommends the sulphate of copper as the emetic which should always be chosen. Apomorphine and ipecacuanha have also been recommended. Oil of turpentine which has not been rectified or which has for some time been exposed to the air has been used with much benefit. This remedy should be given after the stomach has been emptied. It acts by combining with the phosphorus to form a substance which is not poisonous. Thornton of Philadelphia recommends permanganate of potassium as an antidote. It must be given well diluted and in full doses.[1] After the removal of the poison from the system it may be necessary to adopt means to restore the blood to its normal condition or a fatal anæmia from the destruction of red corpuscles may supervene. Trans-

[1] *Therapeutic Gazette*, Jan., 1894.

fusion has been recommended when there is danger to life from the inadequacy of the blood supply. The gastro-enteritis resulting from the irritant character of the poison also requires treatment.

2. Syphilis.

A special form of syphilitic jaundice, different from that occurring in sclero-gummatous hepatitis, was especially described by Gübler in 1853. This occurs at the onset or early in the secondary stage of the disease.

This condition was referred to by Paracelsus and Portal. The latter believed that in some cases icterus occurred in the primary stage. Lancereaux made a collection of 20 cases, of which 3 occurred in his own practice. In all 3 cases the jaundice appeared at the commencement of the secondary stage. The patients complained of general malaise, headache, loss of appetite, and more or less fever.

The jaundice is not intense, and the urine contains but a small amount of bile pigment. It always appears at the same time as the eruption of the skin. This may be explained on the hypothesis that there existed in the biliary passages an internal roseola. A few days or a week are required for its development, and it lasts for twenty or thirty days. It may run a course so similar to that of catarrhal jaundice that it may be difficult or impossible to make a distinction. Its rapid cure by the use of antisyphilitic remedies is often the most ready means of diagnosis. It is probably due to the action of the syphilitic poison on the hepatic parenchyma. Salomon points out that early syphilitic jaundice is an indication of feeble resistance, and on that account is of prognostic importance.

3. Alcohol.

The effect of alcohol on the hepatic cells has not been clearly defined. It is quite evident, however, that either the alcohol itself or compounds formed in the digestive tract after its ingestion when carried to the liver act as direct irritants to the hepatic cell. It is probable that the jaundice which follows the taking of large quantities of alcohol is the result of its direct irritant action on the liver. In cases of acute alcoholic cirrhosis, such as have been described by English writers under the term red atrophy, the hepatic cells appear to be affected earlier and to a greater extent than the connective tissue.

4. Toxins of Infectious Diseases.

A good deal of attention has recently been paid to the investigation of the effects produced on the hepatic cells by the various toxins of infectious diseases. Roger by the injection of the bacillus septicus putridus has demonstrated a number of varied lesions of the liver.

The rapidity with which toxins may form and exert their deleterious action on the hepatic parenchyma was well illustrated by some cases recently observed in the laboratory of Johns Hopkins Hospital by Flexner. Three children died from the effects of a burn, one within

eleven hours of the accident. At the post-mortem examination of the latter case extensive changes were found in many of the organs of the body. The cut surface of the liver presented evidences of cloudy swelling, the cells were enlarged, and the contour of the lobules indistinct. Small thrombi were also found in the venous radicles made up of fibrin and broken-down corpuscles. The changes in the cells which had taken place within ten hours were probably caused partly by the great number of venous thrombi cutting off the blood supply, as explained by Flexner, and partly by the presence in the blood of a fibrin ferment which appeared to act as a virulent toxin.

The pathological changes caused by certain so-called toxalbumins:[1]

Very similar changes were found by Flexner in his experiments made on animals by the introduction of certain vegetable and animal toxalbumins. He made intravenous inoculations of ricin (an amorphous substance isolated from the castor bean and very toxic to animals) into the rabbit, and when a moderate dose was used so that death did not occur until twenty-four or twenty-six hours, the following changes were found to have taken place: The liver was dark in color and often much congested, and presented to the naked eye foci of yellow or yellowish white color, which at times were surrounded by hemorrhagic zones.

"In the capillaries of the liver, which are greatly dilated, the epithelial cells are sometimes fragmented and necrotic and the leucocytes suffer a similar change. But in the liver cells themselves the process reaches its height. The yellow and yellowish white areas visible to the naked eye correspond to foci of coagulation necrosis of liver cells. The liver cells in these areas are still preserved in some instances, but they are hyaline in appearance and devoid of nuclei. At times the nuclei can still be made out in the form of fragments. In other foci the cells are much altered in appearance and staining properties, and the nuclei have undergone another form of necrosis. They have not fragmented, but have died as a whole, becoming paler and paler, until finally they fail to stain, with apparently a synchronous alteration in the cell protoplasm. Still other cells have given up most of their protoplasmic material and appear as almost empty vesicles, with here and there a trace of protoplasm. Again, a group of cells will be converted into a reticulated substance resembling fibrin; and indeed these foci of necrotic cells often give a reaction with Weigert's fibrin stain, while the remainder of these tissues does not retain the dye.

"The foci of necrosis are often surrounded by large quantities of nuclear detritus—to such an extent, indeed, as to exclude the possibility of its having been derived altogether from the tissue nuclei. Some of the detritus must have come from emigrated cells, attracted, as we know commonly happens, to these necrotic foci, where they suffer the same fate as the tissue elements. An interesting feature was noticed in connection with the lymphatics in the interlobular spaces of the liver. They were at times choked with nuclear detritus. Manifestly, such an amount of material could not come from the cells lining the lymphatics nor from the cells of the lymph. There is only one interpretation of this appearance possible: it represents the nuclear detritus of the tissues

[1] *The Med. News*, August, 1894.

and emigrated cells which had been swept by the lymph vessels into the current. To accomplish this it is probable that an increased lymph current is necessary.

"That in the short space of time, about twenty-four hours, rapid cell proliferation occurs in the lymph glands we have adequate evidence, and we have also reason to believe that the same thing occurs in the liver. Around a focus of necrosis about 1 mm. in diameter, in the periphery of which the capillaries were greatly dilated and literally choked with nuclear fragments, there were evidences of cellular proliferation in the rapid multiplication of the liver cells, forming at times actual giant cells."

The injury to the capillary wall was found greatest in the areas of necrosis. The diminished rapidity of the circulation would allow the irritant to act with the greatest intensity, and when the capillary wall was damaged a freer transudation took place into the tissue than elsewhere, resulting in destruction of the hepatic cells.

Similar changes were found in the liver when rabbits were poisoned by the blood serum of dogs, and death was not delayed longer than a day or two. When death did not take place until the twelfth or thirteenth day, they exhibited changes similar to those of the early stages of cirrhosis, which will be referred to elsewhere.

Diphtheria.—The changes found in the parenchyma of the liver in diphtheria are due to the toxin and not to the Klebs-Löffler bacillus, because, as was pointed out by Flexner, the small number of bacilli found in the internal organs is altogether inadequate to explain the pathological conditions present, and cases occur in which no organisms can be demonstrated. These facts would seem to prove that in many of the infectious diseases the great changes which take place in the liver are due to toxins and not to the presence of bacilli.

M. Morel, who examined the livers of 8 children, found the following conditions: The liver is increased in volume, congested, and of a red or reddish yellow color. On microscopical examination there was more or less fatty infiltration, depending on the length of time the disease had existed and on the intensity of the poison. Fatty droplets were found in the cells lining the intralobular capillaries and in the hepatic cells. Toward the centre of the lobule the fatty infiltration was more marked in the endothelial cells, whereas near the periphery the hepatic cells were principally affected. The intralobular capillaries were dilated, and there was an excess of leucocytes. The biliary passages were normal, but in one case M. Morel found desquamation of epithelium.

Typhoid Fever.—The changes found in the liver in typhoid fever have been studied by Amyot,[1] who describes two classes of nodules, the lymphoid and the necrotic. The latter are made up of unstained granular protoplasm, the size of which is much smaller than that of hepatic cells. The capillaries of the nodules are filled with granular material. Besides these nodules there are areas of capillary dilatation with only the nuclei remaining in the hepatic cells. A certain amount of diffuse cell infiltration was also present. Hamilton mentions the presence of grayish yellow specks seen on the cut surface of the liver of typhoid fever, about the size of a pin's head, and not unlike tuber-

[1] *Canadian Practitioner*, June, 1895.

cles. They are masses of necrotic liver cells in a state of disintegration. He was not able to find any bacteria within them.

Variola.—The liver is somewhat enlarged, dark in color, and congested when the patient dies on the fifth or sixth day. The hepatic cells are first granular, and then become infiltrated with fat. The capillaries are much congested. Leucocytes fill the interlobular spaces and penetrate even between the cells in the lobules. Patches of necrosis exist, caused, as maintained by Weigert, by microbic thrombi. The pathological process commences with vascular congestion, the migration of leucocytes, degeneration of vascular epithelium, and lastly degeneration of the hepatic cells.

Scarlatina.—The liver is increased in volume and friable. The vessels are congested and a round-celled infiltration exists between the lobules. There is a cloudy swelling of the hepatic cells, some of which contain a greater or less number of vacuoles.

Yellow Fever.—In yellow fever the liver is usually somewhat enlarged, but it may be normal or slightly atrophied. The color is a bright yellow, but varies from a *café au lait* to an orange yellow. The hepatic cells are pale, slightly granular, and filled with oil globules. Regions of necrosis are also found.

Councilman has described changes in the hepatic cells which he considered to be characteristic. Liebermeister looked upon yellow fever as a parenchymatous hepatitis the result of a specific infection. The biliary passages are free, and the gall bladder is sometimes larger, sometimes smaller than normal, and filled with a greenish colored bile.

5. Epidemic Jaundice.

Jaundice often occurs in an epidemic or endemic form, usually in a limited number of patients extending over a small territory. There are records of such epidemics confined to one or two villages, to certain houses or garrisons. Children are most frequently affected, and in garrisons the younger soldiers are usually the victims. It is quite probable that in a good many of the recorded cases the jaundice may have been due to a catarrh of the biliary passages the result of cold or the ingestion of unhealthy food. The drinking of stagnant water has been the cause in some cases. Many such outbreaks have occurred in malarial districts, and have really been due to malarial poisoning. In some epidemics children alone have been affected, whereas in others the disease has been altogether confined to adults. The different epidemics have varied greatly in their mortality. In one at Chasselay referred to by French writers and in another at Paris not a single death occurred. On the other hand, in an epidemic at Essen, where children were the victims, there was a large percentage of fatal cases. In several instances, notably at Rotherham, the epidemic followed typhoid fever. In an outbreak which occurred at Martinique the disease was very fatal among pregnant women, and 20 deaths occurred in 30 cases. In the milder epidemics—for instance, that of Chasselay—the jaundice was preceded by symptoms of gastro-duodenal catarrh, and probably the inflammatory condition spread farther than the biliary ducts. In the more severe cases, however, and especially when it occurred in pregnant

women, it is probable that the hepatic cells were destroyed by the toxin. The infective agent seems to be of microbic origin and differs in the different epidemics. In some it is contagious and infectious, whereas in others it would appear to be simply infectious. Karlinski has recently described 5 cases of epidemic jaundice somewhat similar to Weil's disease. Jaundice, albuminuria with casts, and micro-organisms in the blood were the principal features in these cases. The temperature was elevated for three or four days, and then fell to normal, remained so for a similar length of time, and then rose again. These recurrences took place several times, producing a condition somewhat resembling relapsing fever. Mennert reported to the Medical Congress at Berlin the history of an epidemic which occurred in Saxony in 1889. The patients were principally children, 518 cases in all. The initial stage lasted three or four days, and was marked by the presence of fever, vomiting, constipation, and enlargement of the liver and spleen. Two or three days after the fall of temperature jaundice appeared and lasted for about eleven days. 73 per cent. of the children living in that region were affected, and 30 deaths were reported. Denton reported an epidemic of icterus among children who attended the same school, but lived in houses far apart. The onset was sudden, and was accompanied by vomiting, prostration, headache, and pain in the epigastrium. Jaundice followed after three or four days. In some cases of infective jaundice cutaneous eruptions of an urticarial or scarlatiniform character were present. Gastric and intestinal hemorrhages, as well as extravasations into the retina, have been recorded. Congestions of the viscera have been noted on post-mortem examination. Enlargement of the liver and nephritis with swelling of the glomeruli have been observed.

6. Acute Yellow Atrophy; Icterus Gravis.

Definition.—A severe and generally fatal form of jaundice in which the marked characteristics are a destruction of the hepatic cells and rapidly ensuing atrophy of the liver. Some observers, looking at the disease from an anatomical standpoint, have termed it acute yellow atrophy, while others, from the clinical side, give the broader definition, "primary grave icterus."

Etiology.—*Sex.*—Acute yellow atrophy is a very rare disease which is not often seen even by physicians of large hospital experience. It occurs more frequently in women than in men. In 100 cases collected by Legg, 69 were in women, and of Thierfelder's 143 cases, 88 were in females.

It has been frequently observed in pregnant women. In the collection of cases just given 30 occurred during pregnancy, and 3 in childbirth. Of the pregnant women,

3 were in the fourth lunar month.	1 was in the eighth lunar month.
5 " " " fifth " "	1 " " " ninth " "
6 " " " sixth " "	6 were " " tenth " "
8 " " " seventh " "	

Of the lying-in women, 1 was attacked in the first week, 1 in the third, and 1 in the fifth week after confinement.

It will thus be seen that it may occur at any month of pregnancy after the third, and is most frequent after the sixth. It is, however, a very rare disease among pregnant women. Spaeth observed it in 1 out of 33,000 cases, and Karl Brown in 1 out of 28,000.

Age.—It occurs generally between the ages of twenty and thirty years. In Thierfelder's record of 143 cases, 70 occurred between twenty and thirty, 31 before twenty, and 42 after thirty years of age; 2 cases occurred under one year, and 1 case over sixty.

Season.—In Thierfelder's cases 19 were in winter, 20 in the spring, 18 in summer, and 24 in the autumn.

Other Causes.—According to Thierfelder, the previous health of the patient has not exerted much influence. In 7 cases there had been a previous history of jaundice. In 13 cases topers had been attacked, and 8 had previously suffered or were at the time suffering from syphilis. Dissipation, including drunkenness and venereal excesses, preceded the disease in a considerable number of cases. The immediate cause in 1 case reported by Thierfelder was severe mental emotion. In 6 of the alcoholic cases the disease had been immediately preceded by excessive indulgence. Acute atrophy of the liver sometimes, although rarely, occurs during the course of cirrhosis or when there has been marked biliary obstruction. It has also been known to follow some of the severe infectious diseases, as puerperal, relapsing, and typhoid fevers.

Changes very similar to those of acute atrophy occur in phosphorus-poisoning, as has already been described. One might conclude from the similarity between these two pathological conditions that both are caused by poison circulating in the blood. In acute yellow atrophy the morbific agent may be a micro-organism or a toxin either produced by the latter or absorbed from the digestive tract. It is probable that the agent is not the same in all cases. Budd, and afterward Trousseau, suggested the presence of some special poison formed in the body by faulty digestion and assimilation, and were of the opinion that intense mental emotion might tend to the production of this poison. Murchison considered that acute yellow atrophy was a general rather than a local disease, and that a poison circulating in the blood affected particularly the liver, but that other organs did not altogether escape. Bucquoy, Bindel, and Steiner have discovered in the brain a fatty degeneration similar to that found in the liver. Degeneration in the muscular system, especially the heart, has been observed by Frerichs. Rangart and Mathieu made cultures from the liver and lungs in a case of acute yellow atrophy. They discovered a new microbe, an anäerobic strepto-bacillus, sometimes slightly rounded and curved. Inoculations with pure cultures caused the death of guinea-pigs, and atrophy of the hepatic cells was found on post-mortem examination.

Pathological Anatomy.—The hepatic cells are first enlarged and obscured by albumin granules—cloudy swelling. The fat drops appear in rapidly increasing numbers. The contour of the cell gradually disappears, and granular masses with fatty detritus remain. If life is sufficiently prolonged, these become absorbed, leaving only connective tissue, bloodvessels, and pigment masses. The intensity of the degeneration varies in different parts of the liver. In one situation

nothing but granular and fatty masses may appear, whereas in others the cells may not be completely destroyed.

Microscopical examination of the detritus of the liver reveals granular matter, masses of bile pigment, crystals of hæmatoidin, and bilirubin. Leucin and tyrosin have also been found in the substance of the liver as well as in the bloodvessels. Leucin exists in ball-like masses showing concentric rings and radiating lines, and tyrosin in bundles of needle-shaped crystals. The presence of leucin and tyrosin in the liver is explained on the theory that they are the compounds from which urea is formed, and that, owing to destruction of the hepatic cells, this transformation is not completed.

The quantity of fat extracted by ether has been found to be two or three times the average amount.

The following case of acute yellow atrophy came under the observation of my colleague, Dr. McPhedran, in the Toronto General Hospital, and was published in the *British Medical Journal* of Feb. 10, 1894:

"E. V ——, æt. 24, admitted to the Toronto General Hospital Jan. 31, 1890.

"*History.*—A domestic servant, unmarried. In infancy she had a slight attack of infantile paralysis, from which resulted talipes varus of the right foot; since then she has been healthy. Her father, a brother, and a sister died of phthisis; her family history otherwise contained nothing of note. Her present illness began about January 1st with a cold from exposure. Two or three days afterward she took influenza, and the skin was noticed to be of yellowish color. She had attacks of free epistaxis. She gradually grew worse, the jaundice deepening and the stools becoming clay-colored and offensive. She complained of pain in the hepatic region. Her appetite was capricious, but that was attributed to pregnancy, which was supposed to be of about five months' duration. There was occasional vomiting of her food, with some slightly bile-stained mucus. Her mental condition was clear until near the end of January, when she began to grow apathetic and dull of comprehension. She continued to work until after the middle of the month.

"*Present Condition.*—She is very deeply jaundiced, fairly nourished, evidently between five and six months pregnant. The only answer that can be got to any question is 'The last three weeks.'. Her pupils are small but active. There is some brownish, sticky mucus adhering to the lips and teeth. She lies quietly, taking notice of nothing; takes liquid nourishment when offered. Temperature in the axilla 97.4° F., pulse 76. The abdomen is somewhat distended and tympanitic. The area of hepatic dulness terminates an inch above the margin of the ribs; the surface seems tender to pressure downward as well as upward under the ribs. The area of splenic dulness extends to the margin of the ribs. Heart and lungs present nothing abnormal. Urine normal in quantity, dark, acid; specific gravity 1023. Tests readily give evidence of the presence of bile pigment. On microscopical examination crystals of leucin and tyrosin are easily found; bowels constipated; considerable nausea with vomiting of bile-stained mucus.

"Feb. 1st. The hebetude has deepened to semi-coma, with muttering delirium. Patient vomits everything that is given, also much dark

grumous fluid. The pulse continues slow and the temperature subnormal.

"Feb. 2d. Comatose with occasional muttering. Pupils small, but respond to light. Grumous vomit continues at intervals. Liver dulness still further diminished. Patient died at 9 P. M.

"Necropsy, eighteen hours after death: Body fairly nourished; rigor mortis well marked. General surface and mucous membranes deeply jaundiced. Pupils dilated. No cutaneous hemorrhages. Pericardium bile-stained and contains one ounce of bile-stained serum. Endocardium bile-stained, also ante-mortem clot in right ventricle. Condition of the muscles not noted.

"Pleuræ: numerous hemorrhagic patches in the right; recent adhesions in the left. Lungs deeply congested. Peritoneum bile-stained. Spleen large and soft. Kidneys: capsules slightly adherent; cortex enlarged. Liver had receded under the ribs; weighed twenty-five ounces; very flaccid, rather than friable; mostly red, with some yellow patches; surface wrinkled. The condition of the gall bladder was not noted. Stomach distended with gas and contained much grumous fluid. Intestines contained much flatus; hardened fæces in colon. Uterus contained a five months' fœtus, which had been dead some days. Unfortunately, the pathologist who conducted the necropsy only preserved the liver for examination.

"The author was present at the post-mortem examination, and noticed the well-marked appearances of acute yellow atrophy, of which the organ was a most typical specimen. A very careful histological examination was made by Drs. McPhedran and McCallum. A large portion of the liver was found to be in a state of red atrophy. In nine tenths of each section examined hepatic cells were not found at all. The latter were present in parts adjacent to the capsule. An interesting point established by the histological examination was the regeneration of hepatic cells, which seems to take place to a large extent in this disease.

"Examples of cell division amongst the nearly normal hepatic cells are sufficiently abundant to warrant the conclusion that just as there is atrophy in one part, there is regeneration of the hepatic parenchyma in another. One might search for a long time in sections of the normal liver without finding as many cells dividing as we saw amongst the remaining cells of a few of our sections. It might be possible in this way to explain the cases of recovery from attacks of acute yellow atrophy which have been reported."

The writers were of the opinion that the destruction of the hepatic cells was caused by "an abnormal albumin which resulted from deranged or putrefactive processes in the intestine."

In the early stage the liver is enlarged and the cut surface anæmic and of a greenish brown color. The whole organ becomes soft and pliable in the later stages, and becomes stained with bile, which, with the masses of fat, produces an orange or an ochre yellow color. The cut surface shows evidences of fat. When absorption takes place the liver diminishes in size, and sometimes the atrophy is intense, the organ being not more than one third the normal weight. It then presents a bright yellow color, with portions of a deep brown color. When cut it

gives the impression of being hard and tough, owing to the excessive proportion of fibrous structure. The dimensions of the liver are lessened in every direction, but especially in its thickness, which gives it a flattened appearance. The capsule is wrinkled and thickened. In the advanced stage the bloodvessels are empty and the outlines of the lobules are no longer visible.

Thierfelder describes two forms of degeneration—one in which a uniform yellow color exists throughout, and a second in which the yellow spots which are soft alternate with others which are red, firm, and tough. In the yellow form of atrophy, as well as in the yellow portion of the second form, hepatic cells are often found well preserved and deeply stained with bile pigment, but the contour of the majority of the cells is ill defined. The alteration is less marked in the centre of the acini and increases toward the periphery. In some places, however, especially in the left lobe, the cells have entirely disappeared, leaving only the detritus, made up largely of oil globules of different sizes. In the second form the proportion between the red and yellow varies in different cases and in different parts of the liver. On microscopical examination of the red portions the hepatic cells are wanting altogether or exist singly. The cut surface is in some places homogeneous, and in others striated and fibrous. A few fat globules and bile-pigment granules with isolated bilirubin crystals are found. Klebs is of opinion that these represent two different forms of atrophy, a yellow and a red, whereas Zenker, Rokitansky, and Perles consider the red to be an advanced stage of degeneration. The latter is the view generally held.

The atrophy of the liver is not so marked if the process takes place in an organ which has previously been enlarged and fatty. In other cases, again, extreme atrophy is not found because death has taken place too early. The smallest bile ducts remain intact, and in the red atrophied portions they are often increased in number. The larger bile ducts are usually empty. A plug of mucus is often found in the duodenal extremity of the common bile duct, and the mucous membrane is swollen in the same situation. The gall bladder is generally relaxed and frequently empty. It contains mucus, which is sometimes colorless or gray and sometimes green or yellow. The other organs of the body are more or less stained with bile. The blood is thick and black, and is often rich in urea and tyrosin. Extravasations are found in the peritoneum, stomach, intestines, spleen, mesentery, and pleura. The lymphatic glands around the portal vein are often enlarged. The spleen is nearly always increased in size, and presents an appearance similar to that in infectious diseases. Catarrh of the gastro-duodenal tract, as well as evidences of extravasation, are often found. In the kidney fatty degeneration of the renal epithelium, hæmatoidin crystals, and occasionally leucin and tyrosin are present. According to Hamilton, the kidneys are in occasional cases quite healthy.

Fatty degeneration of the heart muscle, serous effusion into the pleura and pericardium, œdema and inflammation of the lungs, and œdema of the brain have been described in connection with acute yellow atrophy.

Symptoms.—For purposes of description the course of acute yellow

atrophy may be divided into two stages—*i. e.* the prodromal or premonitory stage, and the second stage, in which the serious symptoms manifest themselves. The premonitory stage often does not differ from that of catarrhal jaundice. The symptoms of gastro-duodenal catarrh —want of appetite, nausea, vomiting, constipation, and more or less tenderness over the hepatic region—are immediately followed by jaundice. According to Frerichs, the discoloration begins in the face and neck and gradually spreads over the body. This stage may last a few days or two or three weeks. In the more acute cases the disease is ushered in by a rigor, and the severe symptoms at once appear. In such cases death has followed in from thirty to forty-eight hours. Loss of strength, muscular pains, tremulous tongue, and nose-bleeding have also been noted. When this stage lasts some days, cardiac asthma, with increased tension and irregularity of the pulse, supervenes. The second stage is marked by severe nervous disturbances. The patient is restless and throws himself about on the bed, and delirium, which may be of a low, muttering character, is soon followed by coma. Breathing becomes irregular and stertorous and the coma deepens until the end.

The atrophy of the liver, as shown by physical signs, is one of the most marked features of the disease, and occurs during the last four or five days. Dulness is diminished from the lower margin upward, and first disappears over the left lobe, and then over the right, so that finally the area may be confined to a narrow band in the right axillary line. It is, as a rule, not difficult to distinguish between this condition and the lessened hepatic dulness which is present in meteorism ; as in acute atrophy, the walls of the abdomen are so relaxed that the hepatic region can be easily palpated. The sharp margin of the collapsed liver can sometimes be felt. In some cases the liver is first increased in volume, and these cases are not to be confounded with those of previously existing enlargement. It is quite probable that in the majority of cases of early enlargement this condition is due to previously existing disease. Then, again, cases have been described in which the evidences of atrophy were not present. This may occur when death takes place before sufficient time has elapsed for the development of atrophic changes. In a third class of cases the degeneration and absorption of hepatic cells may be accompanied by a hypertrophy of the connective tissue.

Pain and tenderness over the region of the liver are not constant symptoms. Frerichs found them present in three fourths of his 31 cases. In Thierfelder's cases pain is not mentioned in one third, and in one fifth it was absent. The pain often radiates toward the right shoulder. It is possible that the tenderness over the liver may really exist in the skin, resulting from hyperæsthesia, and may not indicate hepatic disease.

Icterus is an early symptom which was present in about two thirds of the reported cases. In about one fourth it appeared on the seventh day, and in a few cases it commenced as late as two or three weeks. In the great majority the jaundice is most pronounced, the skin becoming of a deep yellow, orange, or greenish hue. In some cases, notably one reported by Bamberger, the skin remained normal in color. The

eruptions peculiar to intense jaundice, such as roseola, petechia, and ecchymosis, are often present. In a few cases, owing to the short duration of the disease, jaundice may not appear until within twenty-four hours before death. The sensibility of the skin is not usually affected. Hyperæsthesia is occasionally present, but is soon followed by anæsthesia.

Bile pigment is usually detected in the urine by Gmelin's test, but when jaundice is slight this test may not be reliable. The biliary acids have also been found in the urine in the great majority of cases. The amount of urine is usually diminished; in fact, anuria may be established before the close of life. The specific gravity varies between 1012 and 1030. The reaction is acid; albumin is found, but not in large quantities. In the sediment, which is of a brown or greenish color, leucin and tyrosin are present, and are of importance from a diagnostic standpoint. Besides these crystals, fat granules, fatty casts, and tubular epithelium stained with bile are found. Urea, which is increased in the premonitory stage, becomes lessened in amount as the disease progresses. It may fall to seven grains in twenty-four hours, and cases have been recorded in which it was absent. Its place is taken by the less oxidized products, creatin, leucin, tyrosin, xanthin, hypoxanthin, etc. Lactic acid and a substance similar to peptone have been found. Phosphates, sulphates, and chlorides are diminished in amount.

Symptoms in connection with the gastro-intestinal tract continue and become intensified in the second stage. The tongue is coated with a grayish white or brownish yellow color; sores appear on the lips and teeth; hemorrhage from the gums produces in the mouth a dark sticky mucus. Vomiting and, toward the last, obstinate hiccough are generally present. The stools are usually of a grayish white color, but in the course of the disease the yellow color may return for a time. The spleen is generally enlarged to a sufficient extent to be readily noticed on percussion, but great enlargement of this organ does not occur.

The pulse is small and rapid and of low tension. The face sometimes becomes livid as the result of cardiac dyspnœa. Myocarditis, pericarditis, and endocarditis are often present. Blood obtained by venesection has been found to contain tyrosin. The white corpuscles are increased in number, and there is usually more or less destruction of the red. Hemorrhages have been observed in more than one half of the recorded cases. Hæmatemesis is the most frequent form. The vomited matter varies in color, depending on the amount of blood present. These hemorrhages occur in the last two or three days of the second stage. The temperature may be slightly elevated during the first stage, but is often subnormal throughout. In some cases it rises slowly before death, and may rise as high as 104° or 105° F. The absence of fever in the beginning of the second stage is almost a constant phenomenon.

Symptoms connected with the nervous system are also well marked. They are those of an acute intoxication—headache, insomnia, intolerance to light, agitation, prostration, delirium, jactitation, cramps, subsultus tendinum, and convulsions. These terminate in coma, during which the pupils may become dilated and insensible to light. The breathing becomes stertorous, and there may be involuntary discharges

of fæces. In the early stages Frerichs noticed xanthopsia, and double amaurosis has been observed. The general nutrition of the body is usually not much affected, as the disease is of short duration. Œdema of the legs and feet has been noticed in patients previously debilitated. Transudations into the serous cavities are rarely found.

Course and Duration.—Fagge mentions five days as the length of time from the commencement of the characteristic symptoms. Niemeyer gives ten days as the average time, and 1 case is reported in which the second stage did not last more than twenty-four hours. Liebermeister gave the duration as four to six days after the appearance of jaundice, and one to three days after the appearance of brain symptoms. There are occasional cases which have extended over two or three weeks. Homans relates one in which death occurred after fourteen weeks' illness. Thierfelder gives the following table of duration in 102 recorded cases:

Within 4 days,	5,	all in pregnant women.									
Between the 5th and 7th days,	18;	of these	10	were	in	pregnant	women.				
Between the 8th and 10th days,	14;	"	4	"		"		"			
Between the 11th and 14th days,	17;	"	6	"		"		"	1	with red atrophy.	
Between the 15th and 19th days,	9;	"	2	"		"		"	2	"	"
At the end of the 3d week,	13;	. . . . .							5	"	"
In the 4th week,	6;	. . . . .							2	"	"
After 4 to 4½ weeks,	10;	. . . . .							7	"	"
After 5 to 8 weeks,	10;	. . . . .							6	"	"

From this table it would appear that in pregnant women the disease runs a much more rapid course, also that red atrophy occurs in those cases which last longest—an evidence of the more advanced character of this form of the malady.

Pathology.—The process whereby the liver becomes so much changed in appearance and structure has been explained in two very different ways. Frerichs, Bamberger, and Liebermeister looked upon it as a diffuse inflammatory process, whereas Rokitansky, Henoch, Leyden, and Klebs considered it to be a retrograde metamorphosis of cell elements. The diffuse hyperplasia of the connective tissue and its infiltration with lymphoid cells (which has been described as occurring in the advanced stage of the disease) favor the view of inflammation. The earlier changes in the liver, such as are found in the yellow portions, are of a degenerative character. A number of theories have from time to time been given which are quite untenable with the light we at present possess.

The close resemblance between acute yellow atrophy and phosphorus-poisoning has led to the view that in the former the destruction of hepatic tissue is the result of the presence of a toxin in the blood. So close is the resemblance that some authors have expressed the opinion that many reported cases of atrophy are really the results of phosphorus-poisoning.

As to the origin and nature of these toxins different opinions have been expressed. Gerhardt thought the reabsorbed biliary acids, being insufficiently eliminated by the kidneys, accumulated in the blood, and thus produced the changes in the liver. It is probable that the agent is

either a micro-organism or a toxin, the latter resulting from abnormal chemical changes in the blood or in the intestine. Whatever may be the nature of the poison, the liver is in all cases the primary seat of the disease, and the changes noted elsewhere in the body are either the result of the hepatic disintegration or of the toxin which is the active agent.

Diagnosis.—In the prodromal stage the symptoms are not very different from those of catarrhal jaundice. Severe symptoms, such as vomiting and great prostration, are less frequent in ordinary hepatic affections. The marked diagnostic symptoms begin in the second stage, such as intense jaundice, hemorrhages, and the peculiar nervous symptoms. In addition to these, there are the lessening of hepatic dulness, the increase in the size of the spleen, and the peculiar character of the urinary sediment. Cases frequently occur, however, in which some of these signs are absent. There may be no lessening of hepatic dulness, no increase in the size of the spleen, and leucin and tyrosin may not be present in the urine.

Prognosis.—The disease nearly always terminates fatally, although there is nothing in its nature which would prevent the possibility of recovery. On post-mortem examination, as a rule, portions of the liver can be found in which the hepatic cells are not destroyed, and if the destructive process should cease, one can readily believe that that portion of the liver which still remains healthy may carry on its functions. It is also quite possible that a regeneration of hepatic cells may take place, as has been demonstrated by Hoffmann, in the livers of individuals who had died within two or three weeks after severe typhoid fever. Cases of recovery have been reported by such an able observer as Frerichs. In these there were present lessened hepatic dulness, jaundice, hemorrhage, and cerebral symptoms, and in Schnitzler's case there were also leucin and tyrosin in the urine. It is therefore probable that in a few cases recovery takes place, but that in the great majority the disease ends fatally.

Treatment.—The diet should be of an easily digestible, unstimulating character; milk is probably the best. In the early stages calomel may be given, followed by a saline laxative. Budd has recommended the following:

℞. Magnesii sulphatis, gr. 60;
Magnesii carbonatis, gr. 10;
Spiritus ammoniæ aromatici, ♏30.
Sig. One such dose three times a day.

Intestinal antiseptics, such as salicylates, salol, and benzo-naphthol, have been recommended. Remedies which have been found of service in phosphorus-poisoning, such as ozonized turpentine, have also been used. In all cases the most distressing symptoms require prompt treatment. For the nausea and vomiting small pieces of ice, carbonated water, bismuth, and sinapisms over the epigastrium are indicated. To relieve the brain symptoms cold applied to the head in the form of ice bags or the Leiter coil has been recommended. Stimulating enemata are also indicated in the final stage of collapse. Liebermeister recom-

mends quinine in moderate doses, and Murchison for the elimination of urea prescribes hot-air baths, diuretics, and colchicum. A case of recovery is reported in which aconite had been used, and another which Lebert treated with benzoic acid.

ABSCESS OF THE LIVER.

Classification.—Suppurative diseases of the liver may be classified as follows: (1) Abscess from suppurative cholangitis; (2) pyæmic abscesses: (*a*) arising from the hepatic arteries in general pyæmia, and (*b*) from retrogressive embolism in the hepatic veins; (3) an infectious inflammation in any part of the portal system, as dysentery, appendicitis, suppurating glands, ulceration from gall stones, and suppurative pylephlebitis; (4) in newborn children the result of umbilical phlebitis; (5) single large tropical abscess: (*a*) phlegmonous, (*b*) fibrous, (6) suppuration the result of traumatism; (7) from foreign bodies and parasites; (8) the result of tuberculosis.

(1) Under the head of Suppurative Cholangitis we have already described the hepatic abscesses which accompany that condition (p. 442).

(2) Pyæmic abscesses of the liver may result in puerperal septicæmia, surgical injuries, septicæmia after typhoid fever, endocarditis, and infectious aortitis. The process in the liver is much the same no matter where the focus of infection may be. The micro-organisms pass through the hepatic artery into the capsule of the lobule, forming infectious emboli. A double local action follows—irritation from the presence of the bacteria and disintegration from the toxins which they produce. The organisms most frequently found are the streptococcus pyogenes and the staphylococcus aureus and albus.

Eichhorst is of opinion that when pyæmic abscesses are found in the liver, the result of infection through the systemic circulation, and the lungs do not present any lesion, the emboli may be so small as to pass through the pulmonary capillaries and thus reach the left side of the heart. Heller thinks that in the lungs the direct merging of the terminal branches of the arteries into the rootlets of the veins furnishes a way for the passage of emboli. Several authorities, Osler among others, think that emboli may possibly pass in a retrogressive way from the right side of the heart through the inferior vena cava into the hepatic veins, and thus become lodged in the smaller branches. Meckel has shown that metastasis through the hepatic vein is not infrequent. It has been proven by experiment on rabbits that quicksilver may pass from the superior vena cava into the liver; but objection has been made to this experiment on account of the weight of the mercury. Fine wheat meal has been used in the same way by Heller. He compressed the thoracic muscles for a few seconds after the introduction of the powder, and found the starch particles lodged in the hepatic vein. Diemer has demonstrated the fact that in the rabbit at the systole of the right auricle blood is driven back into the inferior vena cava. When the emptying of the right auricle is interfered with, the blood will most probably pass

into the inferior vena cava with such force as to carry emboli into the hepatic vein. Some of the older surgeons were of the opinion that abscess of the liver occurred more frequently in disease of the cranial bones, and supposed that a more direct relationship existed between the liver and cranium than between the former and the other parts of the skeleton. This idea first originated in the fact that wounds of the scalp are more common and are more often followed by pyæmia.

The comparative frequency of pyæmic abscesses of the liver is shown by the following statistics, published by Barensprung: In 108 out of 7326 autopsies lesions of the liver were found: of these, 30 were of pyæmic character.

The pyæmic liver is large, soft, and friable, and is filled with small miliary nodules about the size of peas. The abscesses are always multiple, and are of different sizes and ages if the infective emboli have invaded the organ at different times. At the periphery of the abscess the hepatic tissue is hyperæmic and of a brown color. The contents are greenish or of a grayish green color, and there is an absence of pyogenic membrane. They commence as foci which are of a greenish color, and these afterward become small deposits of pus. They coalesce, forming larger cavities.

(3) Infective inflammation in any part of the portal vein is a very common cause of multiple hepatic abscesses. The process was first demonstrated by Cruveilhier, who after injecting mercury into the portal system of animals found abscesses in the liver, each with a globule of mercury in the centre. Abscesses have also been produced by the injection of pus into the portal vein. A thrombus in some branch of the vein is a common source of suppurative hepatitis. A part of the thrombus breaks off and is carried to the liver. Ulcerative and suppurative processes in parts from which the portal vein derives its blood may give rise to thrombi or may communicate directly with the venous radicles. In many cases where abscesses are found the original cause has disappeared. Among the infective inflammations of the portal vein may be mentioned inflammation of the splenic and pancreatic veins, phlegmonous gastritis, and ulcerations in the gastro-intestinal tract. Tubercular ulcers in the intestines are rarely the source of abscess. Typhoid ulceration, suppuration of lymphatic glands, dysentery, and occasionally catarrh or follicular inflammation of the mucous membrane of the intestines, may be the source of disease. Ulceration of the appendix vermiformis is not infrequently the cause of hepatic abscess. The presence of foreign bodies in the appendix has also given rise to abscess, as well as wounds of the rectum, suppurating hemorrhoids, and operations around the rectum.

The accompanying illustrations (Figs. 27, 28) were made from photographs which were taken by Dr. John Caven of a case which had been under Dr. McPhedran's care in the Toronto General Hospital. The patient suffered from abscess of the liver, which made its way through the diaphragm and pleura and opened into a large bronchus. Death from pyæmia followed. At the autopsy a pin was found in the appendix, which was the starting-point of the pylephlebitis and subsequent hepatic abscess.

Multiple abscesses commencing in the radicles of the portal vein

resemble in their development those of pyæmic origin already described.

In this connection infarction of the liver will be referred to. This condition is quite rare, owing to the small size of the hepatic artery and to its not arising directly from the aorta. The free anastomosis of the three sets of capillaries does not favor the arrest of emboli.

Hamilton describes a bacterial necrosis which occurs in the form of rounded or irregular shaped tumor-like masses, which on microscopical examination are found to be made up of dead liver tissue. The border often runs through a lobule, cutting off a part of it. Masses of micro-

FIG. 27.

Appendix vermiformis containing pin.

organisms are found in the branches of the portal vein, and sometimes of the hepatic vein. They do not produce suppuration. This form of bacterial necrosis has been found frequently in animals, and occasionally in man. The organisms are bacilli and micrococci.

Single large collections of pus, the so-called tropical abscess of the liver, is a form of suppurative hepatitis usually found in warm climates, but which occasionally occurs in the temperate zone. In the tropics those who are natives of northern countries suffer most frequently, especially when they indulge in highly seasoned food and alcoholic beverages. The suppuration is always circumscribed, and the abscess, usually single, may attain a great size. According to Waring, the abscesses are single in 62 per cent. of cases, and the remainder are double or multiple. The liver, as a rule, is much increased in size, but

cases have been recorded in which it became smaller than normal. Fagge mentions a case in which 6 pints of pus were found, and McLean one in which there were 13 pints. In 70 per cent. of Waring's cases the abscesses were in the right lobe.

ETIOLOGY.—Since the discovery of the amœba coli by Kartulis the relationship between dysentery and tropical abscess has been made clear in those cases in which that organism is found. In a large proportion of cases, however, the amœba is not present, and in such the

FIG. 28.

Abscess of liver in a case of pyæmic infection through a wound in the appendix vermiformis caused by lodgement of a pin.

relationship between dysentery and hepatic abscess is still under discussion. Many cases of the latter occur without dysentery, and *vice versâ*. In some cases the abscesses precede the dysentery. The fact that in India the disease occurs most frequently in Europeans, and especially those who indulge in alcohol, would indicate that acute hyperæmia of the liver is an important predisposing condition. Malaria, which is so common in warm climates, may act in the same way. It is therefore probable that the active cause is a specific organism which may not be of the same character in all cases.

Inflammation and ulceration of the mucous membrane of the bowels,

although frequent precursors of abscess, are not always present. It is probable that in such cases the organism or its toxin passes directly to the liver.

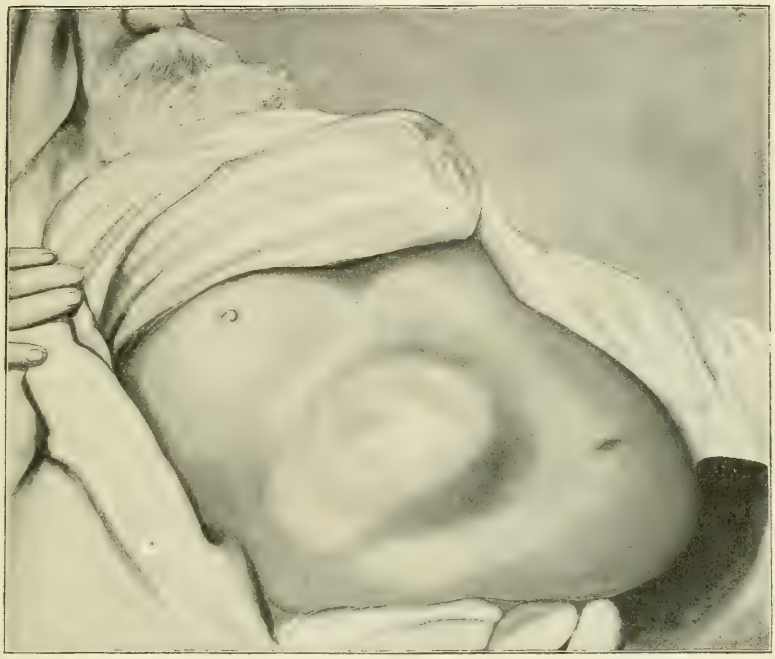
Pathological Anatomy.—Kelsch and Kiener, in the work *Les Maladies des Pays chauds*, describe the changes which occur in the formation of hepatic abscess as follows: (1) A patch which is hyperæmic and inflamed is still hard with a small central portion; (2) a stage in which abscess is formed, with its surrounding wall enlarging constantly from ulceration of the wall or from small abscesses in its thickness; (3) the process of reparation, which follows the evacuation of pus either outward or into the natural cavities. The abscess may develop rapidly or slowly. The pus is not at first serous, creamy, or grumous, but it may be white, green, or chocolate colored. It is green when discolored by bile pigment, and dark when an extravasation of blood has taken place into the cavity. The walls may vary in thickness according to the rapidity or slowness of development. The wall is thick and made up of three layers—an inner layer, grayish and composed of necrotic liver substance; a middle layer, brownish red in color; and an outer one, made up of hyperæmic hepatic tissue. There is no definite limiting membrane.

Kelsch and Kiener have divided hepatic abscesses into two classes, phlegmonous and fibrous. Phlegmonous abscesses vary in the rapidity of their development, and have for this reason been divided into three varieties: (1) The process may involve a large portion of the liver, and be so rapid that death may take place before complete evolution. Upon post-mortem examination the affected portion is found to be softened and of a grayish color, and a small amount of pus may be pressed out from it. This form is fortunately rare. (2) In the second variety the evolution is more complete and the abscess is more circumscribed. The contents in such cases are made up of leucocytes, masses of compressed and necrosed hepatic tissue, grayish granular matter, and bacteria. The wall, which is of a dark red color, is made up of liver structure in a state of inflammation. Softening takes place, as a rule, from the centre toward the circumference. Large masses of necrosed cells of a cheesy consistency are sometimes found in the abscesses. A liquid of the color of chocolate is sometimes present. The contents of an abscess are of a green color when a biliary canal opens into the cavity. (3) In the third variety the development is still slower. In it a number of nuclei are found, between which hepatic structure may exist. When more fully developed the abscess assumes an areolar character. This is the form which exists more frequently with dysentery.

When fully developed the abscess presents the following conditions: The surrounding parenchyma is exceedingly hyperæmic, and in the outer parts the lobules are more or less compressed. The inner surface presents irregularities and villosities which extend into the abscess cavity. Smaller collections of pus may exist in the wall, and the irregularity of the inner surface is due to the rupture of these dépôts of pus into the large central cavity. The cavity enlarges partly by this rupture of smaller abscesses and partly by a necrosis of the wall, which progresses uniformly in the whole inner surface. In cases of recovery after evacuation of the pus a cicatrix is formed, and if there

has not been a very great loss of hepatic tissue, a cure takes place with less change in the form and size of the liver than one would imagine.

Fig. 29.



Abscess of the right lobe of the liver forming a prominent tumor (Osler).

The abscess may rupture, be evacuated, and again become filled with pus.

Fibrous Abscess.—In this form the development of fibrous tissue is an integral part of the process, and the contents of the abscess are separated from the healthy liver structure by a thin wall. They may be solitary, but are usually multiple, from three to twelve being disseminated through the gland. The abscess sometimes is of medium size, but often small, in the form of nodosities which soften in the centre. The pus is syrupy and grumous ; the walls are afractuous and grayish in color. A section of the wall exhibits a hard surface which may be more or less infiltrated with calcareous salts. The fibrous condition probably arises from an attempt at cure which takes place because the germs present possess little infectious power.

Abscesses, whether phlegmonous or fibrous, may take several courses. The contents may become fœtid, owing to the invasion of saprophytes from the intestine. In such cases gangrene may supervene. The odor of chyme has been detected in the abscess contents when there was no direct connection with the stomach. Perihepatitis is a very frequent and very important sequel to abscess. Adhesions may take place to the abdominal wall or to the surrounding organs, and a communication be thus established through which the pus may be evacuated and a cure take place. The most frequent termination is perforation through the

abdominal walls. Rupture may also occur into the pleural cavity, into the intestine, into the pelvis of the right kidney, and into the pericardium. According to Osler, in Waring's 300 cases 16 per cent. were opened by operation, 56 per cent. remained intact, nearly 5 per cent. perforated the right pleura, 9 per cent. ruptured into the right lung, 5 per cent. ruptured into the peritoneum, and nearly 3 per cent. ruptured into the colon. There were in addition cases in which rupture took place into the bloodvessels, into the bile ducts, and into the gall bladder.

Bacteriology of Tropical Abscess.—In 9 cases of the non-dysenteric form Kartulis isolated from 4 the staphylococcus aureus, from 1 the albus, and in 4 cases the results were negative. In 13 dysenteric cases Kartulis found the staphylococcus in 2, the albus in 1, the bacillus pyogenes fœtidus in 1, and in 9 the results were negative. Kartulis discovered an amœba living and moving in the fæces of dysenteric patients, in the ulcerations of the larger intestine, and in the liver. The amœba coli is readily stained by Gram's method, and may exist in the intestine and in a hepatic abscess when there are no signs of dysentery. The amœba coli has been found in the discharges, not only in dysentery, but in diarrhœa, and even in healthy conditions. An increased number of amœbæ has been attended by an increased severity of the disease. This germ produces an inflammation in the hepatic capillaries in two ways—by its presence and by the toxins which it forms. Kartulis also demonstrated by experiments on animals that it is an important agent in the production of hepatic abscesses. Osler, Councilman, and Lafleur have proved the correctness of Kartulis's observations by their careful study of some cases of hepatic abscess in the Johns Hopkins Hospital. Councilman and Lafleur arrived at the following conclusions: (1) That amœbic dysentery should be etiologically, clinically, and anatomically classed as a separate disease; (2) That the amœba is the cause—a fact which has been proved by its constant presence in the tissues and in the stools, and is further confirmed by the inoculation experiments of Kartulis; (3) That abscesses of the liver and lung are much more common in amœbic than in other forms of dysentery. Another specific agent, a bacillus which had previously been described by Chantemesse and Vidal, has been found in some cases. The contents of a number of abscesses seem to be sterile. It is possible that in such cases germs have at one time been present, but have since disappeared. The liver itself may modify the life of bacteria. The sterility of the pus is proved in some cases by its not affecting the peritoneum when rupture takes place.

Clinical History.—The symptoms of tropical abscess vary in severity. A large abscess may exist in the liver without the presence of any marked constitutional disturbance. In many cases there is a presuppurative stage during which the principal symptoms are an enlargement of the liver with tenderness of the surface, a subicteric tint of the skin, and a slight fever. The condition resembles that accompanying congestion from malaria; the latter can be distinguished from the former by a microscopical examination of the blood. Hepatic abscesses have been divided into three clinical classes—acute, subacute, and chronic. In the acute form the fever follows repeated chills and is ac-

companied by nausea and bilious vomiting, together with pain more or less severe felt in the right hypochondrium, more rarely in the epigastrium or some point in the neighborhood. Pain and a feeling of distress are constant and characteristic symptoms of abscess of the liver. The pain is fixed, intense, and deeply seated, made worse by cough, movements of the body, or pressure over the surface of the hypochondrium. In occasional cases it can only be elicited by deep palpation. It radiates toward the right shoulder or down into the lumbar region. It may produce dyspnœa and diminished movement of the lower portion of the right side of the chest. When the abscess is more superficial the pain is acute, resembling that of perihepatitis or diaphragmatic pleurisy. Sometimes in the right shoulder it is very severe, shooting upward to the neck and downward to the arm. The suffering produced by the pain in this region is often as great as that present in the liver itself. The patient may complain of painful respiration and of a dry cough. When a perihepatitis is present a friction fremitus and a friction sound may be noticed. Two signs of Heissler and Boisson[1] which they estimate as of great importance are—(1) a peculiar ballottement and elastic hardness on percussion, similar to that experienced when a rubber ball which has thick walls and is very much distended is struck. (2) On auscultation a *bruit de frémissement*, a fine crepitation like that from pressure on frozen snow, is heard both on inspiration and expiration, but more distinctly with the former. This is not due to perihepatitis, because it has been heard when there was no peritonitis, but the authors think it due to œdema of the liver. They consider these two signs as the most valuable in differentiating between liver abscess and the congestion and enlargement due to malaria. The countenance is often anxious, the conjunctiva is slightly jaundiced, the decubitus is usually dorsal, with the head inclined forward and the trunk curved slightly to the right side. Toward the fifth or sixth day of the disease the fever and pain become less. The remission, however, is short, for the latter soon returns with greater severity, and may be of a throbbing or lancinating character. Rigors followed by fever and excessive sweats indicate the presence of suppuration. After some days a fluctuating tumor may be felt above or below the margin of the ribs or the pus may be evacuated into some of the neighboring cavities. In many cases, however, the pain persists and the patient sinks into a typhoid state, as evidenced by dry tongue, sordes, and subsultus tendinum. In the subacute and chronic forms the symptoms are more slowly developed. In cases of the relapse of pain just mentioned, about the sixth or seventh day a decided amelioration of symptoms takes place, with a tendency to return to the normal condition. In other cases the symptoms continue, but in a less severe form, and after two or three weeks the chronic type may be developed.

The temperature varies in different cases. In some there is an absence of fever, while in others it may be continuous or intermittent. The pulse is generally frequent, small, and compressible. The general nutrition is profoundly affected, and there is rapid loss of flesh and strength. Diarrhœa with bloody stools is often present. The urine contains less than the normal amount of urea.

[1] *Rev. de Méd.*, Paris, 1896, xvi. 785–798.

Methods of Termination of Hepatic Abscess.—In the very acute cases death results from the severity of the constitutional symptoms. A fatal result may follow from marasmus due to the suppuration or to diarrhœa or dysentery which may accompany it. In some rare cases the abscess becomes encysted and the pus is absorbed. The pus may find its way through the abdominal wall—a favorable termination, but one which does not often take place. The surface of the abdomen becomes prominent, and after a time tension of the integument and fluctuation are noticed. Sometimes bullæ appear on the surface. The opening is usually in the hepatic region, but may be in the right axilla, near the umbilicus, or in the right inguinal region. The direction of perforation may be through the diaphragm into the bronchi. This mode of exit is often preceded by consolidation of the lower part of the right lung. The patient may complain of pain, dyspnœa, and cough, with sputum more or less colored by bile pigment containing large quantities of pus. Sometimes only a portion of the matter in an abscess is coughed up, but even this is followed by considerable relief. The opening of an abscess into the pleural cavity is preceded by an adhesive perihepatitis which attaches the liver to the diaphragm. After the opening takes place the usual signs of empyema present themselves, and pus may be readily diagnosed by means of an exploring syringe. It may find its way upward and to the left, opening into the pericardium. Death speedily follows in such cases.

When the abscess opens into the peritoneal cavity the symptoms depend to some extent on the rapidity of development. When the pus accumulates rapidly and rupture takes place early acute peritonitis supervenes and death soon follows. In subacute or chronic abscess the rupture is sometimes followed by signs of local inflammation as well as those of general chronic peritonitis. The hepatic symptoms may be so severe and the accompanying dysentery so intense that the peritonitis may be overlooked. On this account pus has been found in the peritoneal cavity on post-mortem examination when its presence had not been recognized during life. One of the most favorable terminations of hepatic abscess is its opening into a neighboring portion of intestine. In such cases after the formation of adhesions the pus find its way by ulceration into the digestive tract, a process which, as a rule, is followed by a rapid amelioration of the symptoms. If the discharge takes place into stomach, purulent matter may be vomited in large quantities. In one case a severe hæmatemesis ensued. An hepatic abscess may also open into the kidneys and inferior vena cava.

Course and Duration.—In the acute variety the abscess may be formed in from fifteen to twenty days, when there is constitutional evidence of intense poisoning. In much the greater number of cases the course is more subacute, and four or five weeks are necessary for its completion. In the chronic type the process may extend over months.

Diagnosis.—In the earlier stage the symptoms may not differ much from those of severe hepatic congestion, except in the fact that the pain is more constant and more severe. When the disease is fully developed the liver is increased in size, with marked tenderness over its surface. The bulging of the ribs in the lower portion of the right thorax is often noticed. When pus develops toward the surface fluctuation may be

made out and the diagnosis thus established. Under such circumstances the only condition for which abscess of the liver can be easily mistaken is an echinococcus cyst. The long time required for the development of the latter, the comparative absence of fever, and the peculiar fremitus noticed are sufficient to enable the physician to arrive at a correct conclusion. The diagnosis between these two conditions may be further confirmed by the use of an exploring needle and by the microscopical examination of the contents. The intermittent fever which occurs in the early stage of abscess may be mistaken for malaria. The curative effect of quinine in the latter condition will often assist in the diagnosis. The enlargement of the liver due to the presence of carcinoma might present some difficulties in diagnosis, especially in countries where hepatic abscess is common. In some cases carcinoma of the liver may develop with considerable rapidity. The febrile condition is not so marked as that which accompanies hepatic abscess.

A mistake in diagnosis is sometimes made between hepatic and perihepatic abscess. In fact, it would in some cases seem impossible in the earlier stages to make the distinction. In perihepatic abscess the severe pain and great tenderness of perihepatitis occur before the development of pus, whereas in abscess of the liver the perihepatic inflammation with the accompanying sharp pain follows the suppuration.

An abscess in the walls of the abdomen resulting from tubercular disease of the ribs or vertebræ may be mistaken for hepatic abscess. It may be differentiated by a study of the early history of bone disease and by its not moving on deep respiration. Sachs recommended puncturing the abscess with a long needle, and then noting whether it moved with the ordinary respiratory movements of the diaphragm.

The differentiation of right-sided pleurisy is made in the same way as in perihepatic abscess.

Prognosis.—The prognosis of liver abscess is as a rule unfavorable. It depends on (1) the nature of the pyogenic agent, (2) the character of the local process and its extension, (3) the method of treatment adopted. According to Kelsch and Kiener, in tropical abscess, when left alone, there is a mortality of 80 per cent., in late operations a mortality of 70 per cent., and when the abscess is opened early a mortality of 60 per cent. In another series of cases (Ughetti), in 48 patients not operated on there was a mortality of 76.4 per cent., while in 45 cases operated on there was a mortality of 45 per cent. In those in which the disease had pursued its ordinary course the mortality was much less when the pus was discharged through the bronchi. In 33 of these death took place in 14 per cent. Pyæmic abscesses, as well as those resulting from suppurative cholangitis and pylephlebitis, are invariably fatal.

Treatment.—In the presuppurative stage the patient should be kept at rest in bed, and a diet consisting largely of milk with other unstimulating and easily digested food should be adopted. Calomel in small repeated doses as an intestinal antiseptic and purgative may be given. Salol and sodium salicylate may also be given. Local bloodletting by leeches and cups has often been resorted to. This method of treatment is of doubtful utility, and is now generally abandoned. Its advocates recognize its use only in a few cases.

When the abscess is formed an early incision with evacuation of the

pus is the method of treatment which gives the best results. Local revulsives, as blisters and tincture of iodine, have been much used. Purgatives are often of service, but should be given with care. Calomel is most frequently used, and should be followed by rhubarb, jalap, castor oil, or senna. Emetics were recommended by the older physicians, but they are of doubtful efficacy. Opium and its alkaloids are much used for the relief of insomnia; Kelsch and Kiener think that opiates are contraindicated in the relapses of dysentery. The action of the bowels, according to their view, is of great benefit in carrying off poisons from the system. When opium is given under such circumstances they prefer to associate with it some laxative, as rhubarb or castor oil. In the stage of convalescence quinine is of service. Change of climate, as well as the use of such mineral waters as Vichy and Carlsbad, is to be recommended. The early opening of the abscess has frequently been unsuccessful on account of want of care in evacuating the cavity. A trocar has been used which did not allow the semi-fluid contents to pass out, and germs have been introduced from without which have led to decomposition of the pus. It is first necessary to find out the exact situation of the pus, when a free incision should be made, to be followed by a thorough drainage. The syringing out of the cavity with antiseptic fluids may be necessary. It may be impossible to locate the pus without making use of an exploratory syringe. Jessop advocates a thorough cleaning out of the bowels to prevent the liver from being deluged by poisons.

The prevention of tropical abscess is to a large extent under the control of the physician. Europeans living in tropical climates should live temperately. All forms of rich food which would have the effect of producing intestinal irritation should be avoided. Careful attention should be paid to personal hygiene. All the various functions of the body should be kept in as healthy a condition as possible.

Charles Forbes[1] gives the following directions for the prevention of hepatic abscess:

(1) To carefully select the drinking water when in the tropics; allow it to boil twenty minutes and filter it.

(2) Have the filter flushed daily with a solution of permanganate of potash.

(3) Cleanliness of cooking utensils.

(4) Treatment of constipation with calomel, followed by a saline aperient.

DISEASES ESPECIALLY CONNECTED WITH THE HEPATIC CIRCULATION.

The liver is supplied with blood from two sources, the portal vein and the hepatic artery, the former for functional and the latter for nutritive purposes. The circulation of the blood in the liver presents some striking peculiarities: (1) Its low pressure, largely due to the fact that the blood has already passed through one set of capillaries before

[1] *Medical Press*, Aug., 1894.

it reaches the liver; (2) the varying amount of blood which exists in the liver at different times. Sappey has found that the weight of the organ may vary from 1450 to 2000 grammes. The volume of the liver changes from time to time in ordinary conditions of health, as can sometimes be demonstrated by physical signs. The reason for this becomes more apparent when, for instance, we compare the circulation of the pancreas with that of the liver. In the former the amount of blood is regulated by the size of the pancreatic artery, and is directly under the influence of the vaso-motor system. The circulation is also influenced by the general blood pressure and by the outflow through the pancreatic veins.

The liver is supplied by a relatively small amount of blood through the hepatic artery and this becomes venous before it reaches the hepatic cells. The portal vein conveys to it the great mass of blood, and the supply is not uniform, but governed largely by the digestive process. When food is not being digested the amount of blood in the portal system is very small and the pressure low. On the other hand, during digestion the minute arteries of the digestive tract, pancreas, and spleen are dilated and filled with blood, while the pressure is maintained. The portal system then becomes congested and the pressure increased. The peristaltic action of the intestines aids in the maintenance of the pressure, while the spleen by its muscular tissue acts as a pump in driving the blood through the splenic vein to the liver.

Although the blood circulates through the liver at low pressure, there are abundant means whereby the circulation can be effectively carried on. The patency of the hepatic veins, the peristaltic action of the intestine, the rhythmical contraction of the walls of the portal veins, the thoracic expansion and contraction, and the aspiratory action of the right ventricle in diastole,—all these assist in the hepatic circulation.

The circulation of the blood through the liver can be very much influenced by the vaso-motor system, as was demonstrated by Claude Bernard. Trench has shown hyperæmia of the liver following section of the splanchnic nerve or when the cœliac ganglion was extirpated.

Hepatic Congestions (1. Active; 2. Passive).

1. Active Congestion.—The amount of blood in the liver varies in health, and an increase of size of the organ may be perceptible by physical signs, and is most likely to occur after a heavy meal of fatty or saccharine food with alcohol. Condiments, such as pepper and mustard, seem to increase the congestion.

Etiology.—Causes may be given under two heads: (1) Direct toxic irritation of the hepatic cells; (2) vaso-dilatation the result of nervous action.

(1) Among the toxins may be mentioned alcohol, which is perhaps the most common cause of hepatic hyperæmia. In gout a succession of congestions occur which are partly due to the usual habits of the patient and partly to the gouty poison. Phosphorus has also a direct effect on the hepatic circulation. The toxins of some of the infectious diseases, as typhoid fever and variola, produce congestions of the liver.

Malarial poisons have a similar effect, which will be described more fully farther on.

Congestion of the liver is quite frequent in scorbutus and diabetes mellitus.

Toxins from the stomach in cases of dilatation are stated by Bouchard to act as a cause of hepatic congestion. Portal hyperæmia may arise from localized diseased processes—for instance, from parasites.

(2) Among those causes acting through the vaso-motor system may be mentioned *chilling of the surface* of the body and the frequent congestions which occur in warm climates. It is probable that in the tropics many cases of hepatic congestion are the result either of malarial poisoning or of dysentery. Besides these, however, hyperæmia may arise from heat and other purely climatic influences. A change of residence from the north to the south means a change in the static and dynamic conditions of the various internal organs, and the liver seems to be more especially affected. When a European goes to a tropical climate the respirations are diminished in frequency, the urine is scanty and poor in urea, the weight of the body is diminished, and anæmia may be developed. At the same time, there is an increased activity of the skin and a slight increase in the bile-producing function. Thus there exists a morbid tendency to congestion which may be precipitated by a chill, an acute attack of indigestion, or the poison of an infectious disease (Chauffard).

Traumatism.—A severe blow over the surface or in the neighborhood of the liver produces congestion of the latter through the vaso-motor system.

Suppression of Habitual Discharges.—In some individuals congestion of the liver occurs during the time of the menstrual flow if the latter is diminished in quantity or altogether suppressed. This may arise from uterine or ovarian irritation through reflex action, or possibly from mental emotion, chills, etc., which affect the circulation in the liver and in the genital organs at the same time. The cessation of a long-continued discharge from hemorrhoids may cause congestion, especially in those who from over-eating and too little exercise are predisposed to the latter condition. High living, especially when combined with sedentary habits, tends to morbid hyperæmia, not only on account of the excessive congestion produced by the taking of large quantities of food, but also for the reason that owing to the sedentary habits of the patient the respirations are not so deep and the circulation in the liver is on that account less perfectly carried on. Dilatation of the stomach and overfilling of the bowels with fecal matter, both conditions the frequent accompaniment of sedentary life, to a certain extent tend to a sluggish hepatic circulation.

An increase of fat in the cardiac walls may result in cardiac weakness, and thus assist in the production of hepatic hyperæmia. Active hyperæmia is more frequently found in men than in women.

Pathological Anatomy.—The congested liver is increased in size, and blood of a dark red color flows freely from the cut surface. The parenchyma is slightly friable and of a homogeneous consistence. Subscapular ecchymoses are often noted. The gall bladder is usually distended with rich and highly colored bile. On microscopical examination

the capillary vessels and the lobules are found dilated and engorged with red corpuscles and leucocytes. The hepatic cells are often yellow and filled with pigment granules. In the more grave form, in which hepatitis succeeds congestion, there is an inflammation of the smaller biliary radicles, and granular and fatty infiltrations of the cells are noticed.

Symptoms.—In both active and passive congestions the following conditions are most frequently found: (1) Regular enlargement of the liver, with subsequent diminution in size; (2) smoothness of the surface of the organ; (3) feeling of tension or painful distention in the hepatic region, with tenderness over the surface. Jaundice may be present to a slight degree.

The onset of active congestion is marked by symptoms of a subacute character, a slight chill followed by a feeling of weight, and painful distention in the hepatic region, the pain radiating toward the right shoulder.

On palpation the liver is found to be large and more or less tender. The lower margin may extend two or three finger-breadths below the ribs. After two or three days a subicteric tint is noticed in the conjunctivæ. These symptoms are frequently followed by a bilious diarrhœa. In the earlier stage of hepatic congestion the urine is scanty and of a brownish color, and may contain bile pigment. A slight trace of sugar has also been noticed. During the course of the disease the urine may be much increased in quantity. Although clinicians have differed somewhat in opinion as to the general symptoms which accompany hepatic congestion, there is, notwithstanding, a series of associated phenomena—enlargement of the liver and spleen, anorexia, epistaxis, a bitter taste in the mouth, and abdominal distention—which are present to a greater or less extent in this condition.

The course and duration vary in different cases. In a very mild form the enlargement is so slight that it is difficult to discern it by the most careful palpation. Attacks of a subacute character sometimes follow excessive indulgence in alcohol, and when these occur frequently they may lead to the more serious condition of cirrhosis. Then there is a grave form which occurs in hot, malarial countries, when the congestion in the early stage is accompanied by much more serious hepatic changes.

Prognosis.—This depends on the cause and the ease with which it can be removed. The immediate result is favorable except in some cases of malaria and in some which occur in tropical climates.

Treatment.—In warm climates the treatment of hyperæmia of the liver should be active and energetic. Dry cupping over the surface and the administration of calomel in sufficient doses to produce free fecal evacuations are the first remedies to be employed, and following these intestinal antiseptics, such as salol, should be given. Ammonium chloride, as well as ipecac, has been found of great benefit in India. Nitro-muriatic acid has also been recommended. The diet should be restricted to milk.

The possible influence of malaria should be considered in all cases, and, if there is any suspicion of its presence, quinine should be freely given.

2. **Passive Congestion.**—We are taught by the embryologists that the liver develops at the same time as the heart and in close connection with the right auricle. Moreover, in the adult the distance between the right auricle and the margin of the liver as measured in the inferior vena cava is a little more than one inch. It is therefore quite easy to understand that the hepatic circulation is much influenced by the condition of the right heart. We may occasionally have cardiopathies the result of hepatic derangement, but much more frequently the condition of the liver is secondary to that of the heart. Dilatation of the right ventricle, from whatever cause produced, has a direct effect on the circulation of the liver. This is especially the case when there is tricuspid incompetency and consequent venous pulsation. The force thus developed when exerted on vessels which are not prepared for resistance produces rapid dilatation. The dilated heart is most frequently a sequel of valvular disease, but may be the result of myocarditis, pericarditis, arterio-sclerosis, or chronic processes which obstruct the pulmonary circulation. The pulmonary conditions which may indirectly produce passive hyperæmia of the liver are emphysema, extensive atrophy of the lungs, long-continued compression such as might result from spinal deformity, pleuritic effusion, and thoracic tumors.

Bartels has shown that when the mediastinum is pushed toward the right the vena cava at the foramen in the diaphragm is bent more or less at right angles and obstruction produced. In this way the fact is explained that passive congestion of the liver occurs more frequently with emphysema on the left than on the right side.

In a debilitated state of the system—the result, for instance, of wasting diseases—the cardiac walls may become so much weakened that incompetency and consequent hyperæmia will follow. Osler has reported a case[1] of cardiac hypertrophy, chronic proliferative peritonitis, and recurring ascites with adherent pericardium in which the condition of the liver was of much interest. The patient, a young girl, was fourteen years of age at the time of her death. After the ascitic fluid had been removed by tapping a visible and actively pulsating tumor was noticed midway between the navel and costal border. When grasped by the hand the pulsation was expansile and forcible, a little later than the cardiac impulse. At the autopsy an enormously hypertrophied and dilated heart was found, the right side being especially affected. The pericardium was adherent more on the right than on the left side. The valve segments were normal. The liver was much deformed, firmly adherent to the diaphragm, and enveloped in a thickened fibrous membrane. Bands of fibrous tissue passed into the liver with the portal vein, and Glisson's capsule was in many places greatly thickened. The hepatic vein was enormously enlarged, and on microscopic examination the enlargement was found to extend to the smaller branches, giving the appearance of an angioma.

Pathological Anatomy.—The liver is much enlarged and hardened, and the right lobe is often more hypertrophied than the left. The capsule is tense and smooth, and sometimes thick and opaque. The anterior margin is rounded and the notch deep and well marked. The cut surface bleeds freely, and presents that peculiar nutmeg appear-

[1] *American Pediatric Society*, 1895.

ance the result of staining the centre of the lobule with hæmatin and the light yellow color of the cells near the margin. The light color has been ascribed to fatty infiltration, but this is rarely present, according to Hamilton. There is marked dilatation of the hepatic vein and its smaller branches. When the congestion has existed for some time an increase of connective tissue is found, which is one form of cirrhosis. Atrophy then follows the enlargement. The capsule is wrinkled and the hepatic substance is firm. The toughness is due to the destruction of the hepatic cells (Hamilton). The dilated bloodvessels and Glisson's capsule then form a larger proportion of the liver tissue than under normal conditions. The connective tissue is only slightly increased, and that not in a large number of cases. A distention of the hepatic veins is noticed near the surface. There is frequently an increase of connective tissue in the spleen and pancreas.

Microscopical Anatomy.—In the centre of the lobule the capillaries are distended and engorged with blood. The cells near the hepatic vein are stained with hæmatin, and when cirrhosis occurs the connective tissue is found first between the capillaries and afterward around the lobules. When this occurs the hepatic cells become atrophied and disappear, leaving in some cases masses of pigment (hæmatoidin). According to Hamilton, the capillaries when emptied present the appearance of fibrous tissue, and on this account a hypertrophy of Glisson's capsule is said to take place when none exists. The biliary passages, as a rule, remain normal, but in cases where jaundice is present the smaller biliary radicles may be narrowed by the distended bloodvessels.

Symptoms.—A patient suffering from cardiac liver presents the many and varied symptoms referred to the cardiac condition, such as anasarca, dyspnœa, etc. In some cases of dilated heart the systemic circulation is most affected, as shown by œdema of the limbs, whereas in others the greater changes take place in the hepatic circulation, and the enlargement of the liver is a prominent feature. Hepatic congestion occurs most readily in those who have previously suffered from alcoholism or malaria. Cardiac liver is more frequently the result of mitral than of aortic lesions.

In passive congestion the liver may be very much enlarged, and the increase in volume may take place quite rapidly. The lower ribs sometimes bulge outward. The vertical diameter is especially increased; the anterior margin is well defined, and when fluid is present in the peritoneal cavity the smooth upper surface of the liver can be felt when sudden pressure is made. In extreme cases the margin is found below the umbilicus. Dull pain is often a prominent symptom, and is accompanied by a feeling of weight and distress in the right hypochondriac region. The pain radiates toward the right shoulder and is increased on pressure.

Congestive hypertrophy is sometimes of a pulsatile character; in many cases, however, the apparent pulsation is caused by the systole of the right ventricle or transmitted from the abdominal aorta. The spleen may not be very much enlarged when the hepatic hypertrophy is marked. A subicteric tint is often present, but, as a rule, the urine does not give the reaction for bile pigment. Jaundice is the result of

the pressure of dilated vessels on the biliary radicles rather than from increase of connective tissue. Ascites is not often present unless due to the cardiac condition. The urine is highly colored, owing to an excess of urobilin. The quantity is diminished, and the density is from 1020 to 1035. The uric acid is diminished and the phosphates increased.

The passive congestion of the mucous membrane of the gastro-intestinal tract may produce symptoms of dyspepsia, and the condition of the circulation in the kidney may lead to greater or less impairment in function. Epistaxis, hæmatemesis, and congestion at the base of both lungs may accompany cardiac liver.

In some cases when the right heart returns to its normal condition the hepatic circulation is restored. An amount of enlargement so great that the anterior border may extend as low as the umbilicus may pass away under these circumstances, and the general condition of the patient be much improved. In some instances jaundice supervenes and a fatal result follows. Cases have been described by Talomon in which, after an initial period of some days characterized by anorexia, vomiting, and diarrhœa, jaundice appeared; the urine became scanty, rich in pigment, and poor in urea. A typhoid state supervened, probably the result of the toxæmia when the liver was already weakened by disease. In the great majority of cases, however, death is the result of the cardiac condition.

Diagnosis.—The existence of cardiac liver is not usually difficult to make out. There are, however, cases in which the enlargement of the heart is due to myocarditis, and sometimes occurs after typhoid fever, when the cause of the enlarged liver is not understood. Two cases of this kind have been recently observed by the writer. In both the liver was much hypertrophied, and the real cause, the cardiac weakness and dilatation, had not been noticed. The enlargement of the liver is such a prominent condition that the whole attention may be given to it to the neglect of a careful examination of the heart. The change in volume which often happens in cardiac liver is a most valuable diagnostic sign. If the heart is comparatively healthy, it will be necessary to look for some other cause, as emphysema or pressure of the inferior vena cava between the liver and right auricle from aneurysm or tumor.

When the liver becomes smaller and the general symptoms not only do not improve, but ascites, an enlarged spleen, or jaundice supervenes, we conclude that cyanotic atrophy has taken place. If the ascites is marked, a combination of alcoholic cirrhosis and passive congestion may be present.

The differentiation between passive and active hyperæmia is usually not difficult. The latter occurs in patients who eat and drink to excess and who may be addicted to alcohol. The heart and lungs may be healthy and no cause for obstructed circulation exists.

The hyperæmia during menstruation and that from diabetes can be similarly distinguished—viz. by the absence of heart disease and the presence of other conditions.

Hanot has mentioned the difficulty of diagnosis between cancer of the liver and the terminal stage of heart disease. Anorexia, hypertrophy of the liver, with severe pain and distress in the hepatic region

may exist in both conditions. Albumin is usually absent in cancer, but present in cardiac liver, while the decrease of red corpuscles is more marked in the former than in the latter. In cancer there is greater diminution of the urea and the leucocytosis is more marked. The writer had under observation a case of mitral stenosis with dilated heart and enlarged liver in which near the termination of the disease the pain and distress in the hepatic region were so great that the attending physician thought that cancer was present. The autopsy demonstrated the presence of cardiac liver with very extensive adhesions of a recent perihepatitis.

Treatment.—The treatment of passive congestion of the liver should be directed to the removal of the cause. Rest in bed, light diet (such as milk, beef tea, and prepared farinaceous food), as well as the administration of mild laxatives, are all of importance. The less severe cathartics, such as senna, rhubarb, and colchicum, may be used. Mineral waters, as Kissingen, Homburg, and Carlsbad, have been recommended. Alcohol and highly seasoned food should be interdicted. Digitalis when it agrees with the stomach is one of the best remedies, for by its action the cardiac circulation is more effectually carried on and the liver relieved of blood. Leeching and wet cups over the hepatic region have been recommended.

Abdominal puncture may be necessary when ascites is present, and diuretics are sometimes of use. The great object of treatment should be the restoration of the heart muscle. This may be accomplished by at first rest and massage, and afterward properly regulated exercise. The diet should be of such a character that only the most nutritious and most easily digested food is given. Fresh air and sunlight, with such tonics as will agree with the stomach, are indicated. Nitro-hydrochloric acid is one of the best.

Hemorrhages of the Liver.

Extravasations of blood do not frequently occur in the liver. They may result from traumatism, wounds, or contusions, from poisons, as phosphorus, rarely from disease. They are found in purpura, scorbutus, and leucocythæmia, and sometimes, though rarely, in intermittent fever (Kelsch and Kiener). In cases of cancer of the liver profuse hemorrhage may take place into the cancerous structure. Occasionally hemorrhagic spots are found without any known cause. Frerichs supposed that in such cases there had been a degeneration and rupture of the smaller bloodvessels. Unless the hemorrhage is large the diagnosis is not possible. In large extravasations, however, the liver may so increase in size as to be readily made out on palpation and percussion. In such cases the sudden onset of pain and the feeling of weight and distention in the hepatic region, together with the signs of rapidly increasing anæmia, are the principal diagnostic symptoms. If the capsule is ruptured and blood flows into the peritoneal cavity, symptoms of collapse supervene.

DISEASES OF THE PORTAL VEIN AND HEPATIC ARTERY.

Pylephlebitis.

This term is applied to inflammation of the portal vein and its branches.

The disease exists in two forms: (1) the adhesive and (2) the suppurative.

(1) Adhesive Pylephlebitis or Pylethrombosis.

Etiology.—Pressure on the portal vein, produced by the fibrous bands of perihepatitis or peritonitis or by tumors, gummata, or calculous dilatation of the biliary passages, may terminate in adhesive pylephlebitis. Cancer of the stomach, duodenum, pancreas, omentum, and retroperitoneal glands may have the same effect. The writer has recently seen a case in which an aneurysm of the abdominal aorta pressed the head of the pancreas into the portal fissure, producing an adhesive pylephlebitis which was followed by ascites. This form of the disease has been termed by Eichhorst compression thrombosis. Thrombus may also occur in the portal vein when the blood current is much retarded, or in cases of marasmus such as are found occasionally in pulmonary tuberculosis, and it may occur in the course of cirrhosis.

Cases of chronic pylephlebitis have been described in which a fibrous thickening of the walls takes place, commencing sometimes in the inner coat and sometimes in the connective tissue immediately surrounding the vein. Calcification may supervene. This is accompanied by thrombosis, and may be the result of pressure from gall stones in the common bile duct which have afterward passed into the intestine.

Pathological Anatomy.—The vein is filled with a thrombus which may extend into the smaller branches of the liver. The nature of the coagulum will depend on the length of time it has been in existence. In recent cases it is brownish red in color, but those of longer duration are almost colorless. In some cases the thrombus becomes organized and the vessel appears as a band of solid connective tissue. Thickening of the wall and a roughened condition of the inner coat are often noticed, and fatty degeneration is sometimes found. In the thrombus of cachexia the evolution is not so complete. It may be easily broken down and show no signs of organization. An obstruction to the circulation in one branch of the portal vein may not give rise to very marked symptoms, as the circulation is carried on through the others. When, however, a thrombus forms in a large trunk, the results of the obstruction are found in the dilatation of the vein and its branches, and in all of the abdominal viscera, especially the spleen, peritoneum, and gastro-intestinal tract. The spleen becomes very much enlarged unless a previous thickening in the capsule prevents much change in size. Amyloid degeneration or great loss of blood would also prevent enlargement of the spleen.

The effect of an adhesive pylephlebitis on the liver will depend upon the rapidity with which the thrombus is formed. When sudden, the biliary secretion may be arrested, but this is not the case if the obstruc-

tion takes place gradually. The liver tissue is not destroyed, as it is nourished by blood from the hepatic artery. If the obstruction is complete, the hepatic artery increases in size, and blood is supplied through it not only for the nourishment of the liver, but for functional purposes also. The blood passes from the arterial into the portal capillaries, and it is only when the latter are obstructed that the circulation ceases. The liver may then become atrophied or portions of it undergo necrosis.

Cases of degeneration and atrophy of the liver due to pylethrombosis have been described, but other factors were not excluded.

The collateral circulation becomes after a time established, and is similar in many respects to that given under the head of Cirrhosis (see page 498). The anastomotic veins become very much enlarged, and in different individuals different sets are affected. In the living subject the external abdominal veins are quite prominent.

Symptoms.—A thrombus may take place in the portal vein without giving rise to any local symptoms referable to the liver. Pain is present when there is a surrounding inflammation. Ascites is a prominent symptom, coming on rapidly and recurring soon after paracentesis. It is present in almost every case except where severe hemorrhage takes place into the gastro-intestinal tract or the collateral circulation is quickly established.

Rapid enlargement of the spleen is noticed except in cases of severe hemorrhage.

Dilatation of the subcutaneous abdominal veins is not a constant symptom, and is most marked if an obstruction exist in the inferior vena cava.

Diarrhœa is frequently present. The motions are watery, and in about one third of the cases there is some blood. The diarrhœa occurs at the same time with the ascites, and is due to passive congestion of the mucous membrane.

The urine is small in quantity, of high specific gravity, and of a bright yellow color, with a heavy sediment. In uncomplicated cases there is no albumen.

When jaundice occurs it has no special connection with the pylethrombosis. General marasmus and emaciation with œdema of the limbs supervene sooner or later.

Digestive disturbance, want of appetite, furred tongue, nausea and vomiting, and a feeling of fulness in the abdomen, with some diarrhœa, are frequently noted. Hemorrhage from the stomach or bowels is a common symptom. This is also the result of a passive congestion of the gastro-intestinal tract. The disease may prove fatal in a week or may last for months or years, depending on the amount of obstruction and the rapidity with which it manifests itself.

Diagnosis.—The diagnosis between this form of pylephlebitis and cirrhosis is often very difficult. The history of the case or the existence of some apparent cause may be of service. The onset of ascites is more sudden in thrombosis than in cirrhosis. When pylethrombosis occurs with cirrhosis there is a sudden development of symptoms of obstruction of the portal vein in addition to those already present.

Tuberculosis of the peritoneal cavity often resembles in many respects adhesive pylephlebitis. The presence or absence of enlarged

spleen or the presence of hard masses in other parts of the abdominal cavity may help to distinguish between the two conditions. In tubercular peritonitis the fluid may in occasional cases disappear and quickly reappear, a phenomenon which does not occur either in thrombosis or cirrhosis.

(2) Suppurative Pylephlebitis.

Etiology.—In this form of inflammation an infective agent which has found its way directly into the portal vein through some of the venous radicles of the abdominal viscera is always present. The primary conditions leading to suppurative pylephlebitis may be suppurating hemorrhoids, fistula in ano, dysenteric ulceration, typhoid fever, abscess of the mesenteric glands, diffuse suppurative peritonitis, suppurative splenitis and perisplenitis, ulceration of the stomach or duodenum, submucous gastric abscess, abscess in the region of the liver itself, suppurative cholangitis with gall stones, and cancer of any portion of the digestive tract. A special form of pylephlebitis occurs in newly-born infants from septic infection through the umbilical vessels.

Suppurative pylephlebitis is sometimes caused by the presence of foreign bodies in the intestinal canal. Cases have been reported in which fish-bones, pins, and other articles, when taken into the stomach, have set up ulcerative and suppurative disease. A branch of the portal vein in the intestinal wall may then become inflamed and micro-organisms find their way into the interior of the vessel.

The most frequent origin of suppurative pylephlebitis is suppuration and ulceration in the cæcum or appendix. Appendicitis, whether gangrenous or ulcerative, may terminate in suppurative pylephlebitis, and in all cases of the latter disease a careful examination of the region of the appendix should be made. A vein in the neighborhood becomes inflamed and filled with blood clot which is infected by pus organisms. The inflammation then extends to the trunk of the portal vein and to its branches in the liver. In some cases portions of the original thrombus become detached and pass upward as emboli into the subdivisions of the vein in the liver, thus producing multiple abscesses. Metastatic formations of pus may afterward be found in the lungs, heart, or kidneys.

Suppurative pylephlebitis is occasionally secondary to gastric ulcer and to suppurating hemorrhoids, but these are much less frequently the cause than appendicitis. In suppurative cholangitis the inflammation sometimes spreads to the neighboring veins and results in the formation of a thrombus.

Cases of suppurative pylephlebitis occasionally come under observation in which none of these primary conditions have been found. It is probable that in such instances a small lesion in the abdominal viscera may have been overlooked. A thrombus the result of marasmus might become infected with pus organisms and suppuration follow.

Pathological Anatomy.—The veins are enlarged in places, and when an incision is made the cut surface separates, owing to previous distention with contents which are of a reddish purulent or grumous character. The walls are thickened and the internal coat is of a grayish or yellow color. It may be softened or ulcerated. Sometimes a portion

of the vessel is completely destroyed and the healthy part is filled with a thrombus. In the liver itself the portal veins may undergo great changes. Ulceration and destruction of the walls may take place, and abscesses form in the substance of the organ. Cornil and Ranvier have described these changes in incipient abscess thus: An infiltration with embryonic cells first separates the middle from the external coat, producing much swelling, which is followed by compression of the lobules, flattening, and destruction of the hepatic cells. When the inflammation extends to the biliary radicles, jaundice may supervene. In some cases the abscesses are quite large and few in number, but, as a rule, they are numerous and range in size from a pea to that of a cherry. The hepatic substance surrounding them may be more or less infiltrated with pus, and that existing between the abscess cavities is soft and greenish in color.

Symptoms.—In the majority of cases of pylephlebitis symptoms of the primary disease are present for some days or weeks previous to the commencement of the venous inflammation. The signs of general septicæmia are predominant, and those of venous stasis in the portal vein are of secondary importance. Pain in the hepatic region is nearly always present, and is often severe and of a burning character. A tumor is frequently felt in the hepatic zone. The liver is often enlarged and tender, the extent of dulness depending on the amount of suppuration which has taken place. When the suppuration is confined largely to the portal vein, the liver may not be much increased in size.

The spleen is enlarged, the result of the obstruction of the portal circulation and of the general septic condition, unless the enlargement is prevented by a thickening of the capsule.

Jaundice to a greater or less degree is nearly always present, and is often accompanied by petechiæ. It occurs after the disease has been for some time in existence. The color of the fæces often remains normal. It is probable that owing to the infection the red blood-corpuscles are broken down and bile pigment is formed in larger quantities. Jaundice may depend on the obstruction of bile ducts by pressure of the enlarged veins or from cholangitis. The fever resembles that of general pyæmia: chills occur, followed by great heat of skin and profuse perspirations. Rapid emaciation and great constitutional weakness supervene. The temperature may rise to 106° and then suddenly fall below normal. In some cases the regularity with which the chills take place suggests the possibility of malarial fever. The fever is more remittent than intermittent, and the general condition of the patient is not unlike that of typhoid. Loss of appetite, nausea, vomiting, and diarrhœa are the prominent symptoms. The evacuations from the bowels often contain blood. In such cases the diagnosis between pylephlebitis and typhoid may be difficult. Some years ago a patient entered the Toronto General Hospital with a diagnosis of typhoid fever. He complained of the digestive disturbances usually found in that disease. The abdomen was tympanitic, with tenderness and gurgling in the right iliac fossa; the temperature was somewhat irregular, but had, as a rule, the afternoon elevation. Some spots were observed near the spine which were thought to be those of typhoid. A few days after his admission the patient had a severe hemorrhage from

the bowels, which seemed to confirm the diagnosis already made. It was, however, noticed that the temperature did not fall after the hemorrhage; in fact, it did not seem to be at all affected by it. This was the first symptom which gave rise to doubt. Two days afterward the patient had a severe hæmatemesis, from the effects of which he succumbed. On post-mortem examination a suppurating mesenteric gland was found in the right iliac region, together with suppurative pylephlebitis.

Peritonitis, which is often present, may at first be localized around the seat of the primary lesion and afterward become general. It is often marked by the vomiting of greenish matter and the presence of alternating constipation and diarrhœa. The symptoms of venous dilatation are not so marked as in the adhesive form. The subcutaneous abdominal veins are rarely dilated, and the fluid in the peritoneal cavity, which is not great in amount, may exist partly as the result of inflammation. The secretion of urine is always scanty, and may cease almost altogether. When jaundice is present biliary coloring matter may be found in the urine. The amount of urea is often much diminished, and is less during the febrile paroxysms than in the interval.

The lungs, pleuræ, and joints may become secondarily involved and present symptoms of suppurative inflammation; the course of the disease would then be identical with that of pyæmia. It may last from a few days to two or three weeks, and occasionally as long as six weeks. Death is the usual termination, the result of adynamia or local inflammation.

Diagnosis.—The irregularity of the chills and the prolonged intervals of apyrexia will often serve to distinguish this condition from intermittent fever. The presence of more or less jaundice and the inefficacy of quinine to control the chills will also aid in the diagnosis. In intermittent fever the presence of malarial organisms would at once settle the difficulty.

Catarrhal jaundice is excluded by the presence of rigors and of rapid emaciation and loss of power which are so characteristic of suppurative pylephlebitis. Catarrhal jaundice is in every way a much milder affection than the one now under consideration.

Suppurative cholangitis may be differentiated by the absence of much splenic enlargement and by its running a more latent course. It is accompanied by less emaciation and prostration, and jaundice is an earlier and more prominent symptom.

The differentiation between multiple abscesses of the liver due to emboli passing through the hepatic artery and those occurring in suppurative pylephlebitis may be made by noting in the former condition the absence of the signs of portal obstruction—diarrhœa, enlarged spleen, and ascites.

The diagnosis from typhoid fever is occasionally very difficult. As a rule, the presence of repeated chills, jaundice, and the local signs of pylephlebitis are sufficient to make the distinction. The presence of typhoid spots, the daily changes of temperature, and the comparatively slower pulse indicate the presence of typhoid fever.

In biliary colic there is no enlargement of the spleen, and there is neither the rapid emaciation nor the prostration. The presence of bile

in the circulation, as shown by the characteristic urine and absence of color in the fæces, is a more frequent accompaniment of biliary obstruction than of pylephlebitis. The previous history of gall stones will aid in the diagnosis.

In tropical abscess there is, as a rule, neither enlargement of the spleen nor diarrhœa, and there is an absence of the symptoms of a primary lesion, such as appendicitis. Rapid emaciation and prostration are not accompaniments of hepatic abscess.

TREATMENT.—The treatment is altogether symptomatic. We have no agent which will in any way control or cut short the disease. Hypodermic injections of morphine may be necessary for the relief of pain.

RUPTURE OF THE PORTAL VEIN; FOREIGN BODIES.

Rupture of the portal vein occasionally takes place as the result of injury and rarely as the effect of disease. Frerichs described a case which seemed to have been caused by a fatty degeneration of the walls of the vein. A case of ulceration into the portal vein from pressure of a biliary calculus has been reported in which sudden death took place from hemorrhage. Frerichs gave, among others, the following cases: one recorded by Vesalius, the result of abscess in the wall of the vein. In a man who had suffered from gastralgia and melæna Shenck found the stomach filled with blood and a rupture of the portal vein near the under surface of the liver.

Foreign bodies, gall stones, and **distomata** have been found in the portal vein. Duval[1] reported a case in 1830 in which five or six distomata were found in this vessel. The distoma hæmatobium rarely exists in the portal vein. There is no recorded case in which it was found in the liver.

DISEASES OF THE HEPATIC VEIN.

Dilatation of the hepatic vein is one of the marked features of cardiac liver.

Adhesive phlebitis may occur as a sequel to inflammation of the capsule. If the disease extends to the smaller capillaries, venous stasis in the portal system may supervene.

Frerichs has described a case of perihepatitis in which the inflammation extended along the branches of the hepatic vein until even the smallest ones became obliterated. The lining membrane of the inferior vena cava was corrugated in folds and the sheath of the hepatic vein was thickened. A thrombus was found in the vein which extended to the smaller branches. Obliteration of the portal vein, followed by thrombus, ensued and the case terminated fatally.

Purulent phlebitis may follow hepatic abscess both in the solitary and pyæmic forms. The hepatic is more frequently affected in abscess than the portal vein, because the latter is separated from the parenchyma by Glisson's capsule, whereas the former is in immediate contact with the hepatic tissue.

Hepatic phlebitis is more frequently followed by general pyæmia than portal phlebitis, because the hepatic vein is in more immediate contact with the general circulation.

[1] *Gaz. méd. de Paris*, 1842, p. 769.

A thrombus which breaks down can readily pass into the right side of the heart and thus into the lungs.

It is impossible to differentiate clinically between the two forms of phlebitis. The walls of the hepatic vein are often invaded by carcinoma and the tumor may grow into the lumen of the vessels.

Hepatic Emboli.—Several cases have been reported in which emboli composed of liver tissue have been found in different parts of the body. The first was a case of fatal injury in which the patient was crushed between two cars. The right auricle contained a brownish mass which was made up of hepatic tissue, and even in the left ventricle a small piece of liver substance was found. It had evidently passed from the right to the left side of the heart through an open foramen ovale. Liver emboli were also found in the pulmonary as well as the renal arteries. Similar emboli were found by Schneidel in a case of rupture of the liver the result of a fall. Von Recklinghausen and Von Zenker have also reported similar cases. The patency of the hepatic vein, its intimate connection with the gland structure, and the ease with which a portion of a thrombus may pass into the inferior vena cava explain the possibility of these cases.

Diseases of the Hepatic Artery.

The walls of the hepatic artery are not often found diseased. In cases of cirrhosis where the branches of the portal vein are obliterated by contraction new vessels form in the connective tissue which are continuous with the hepatic arteries.

In cases of cancer of the liver the growth receives its supply of blood through the hepatic artery, and the vessels formed in the tumor may be injected through the aorta. In such cases the vessels may be much increased in size.

Atheroma is not often found, and obstruction by emboli rarely occurs.

Aneurysm of the Hepatic Artery.

This rare condition has been described by Frerichs, and cases have been reported by Stokes, Sestier, Wallman, and Lebert. In one of these the aneurysm ruptured into the abdominal cavity, in another rupture took place into the gall bladder, and a third died of exhaustion.

The aneurysmal tumor may be quite large, causing displacement of the liver.

Symptoms of duodenal indigestion, neuralgic pains coming on some time after eating, pains similar to those of biliary colic, have been noticed in these cases. Hæmatemesis and bloody stools with consequent anæmia have also been observed. The diagnostic signs, besides those of the presence of a tumor, are neuralgic pains radiating to different parts of the body and the presence of jaundice, which arises from pressure on the bile ducts. In the recorded cases neither bruit nor thrill seems to have been made out. A case was reported by Osler in which multiple abscesses were found in the liver.

PERIHEPATITIS.

Definition.—In the study of inflammatory conditions in the neighborhood of the liver it is necessary to remember that there are two distinct capsules, the inner one continuous with that of Glisson, and an outer one constituting part of the peritoneum. Between these two there exists a rich venous plexus. An inflammation may proceed from without inward, producing a perihepatic peritonitis or from within outward, producing perihepatic capsulitis.

Perihepatitis has been divided by Chauffard into four classes: (1) Fibrous, (2) Suppurative or pyo-perihepatitis, (3) Pneumo-pyo-perihepatitis, (4) Tubercular perihepatitis.

(1) **Fibrous Perihepatitis.**—The dry variety is distinguished by fibroid thickening of the capsule as well as by a superficial exudation.

Etiology.—Tight lacing when it produces change in the form or position of the liver is apt to set up this form of perihepatitis. The latter often results from trauma or may be developed secondarily to many hepatic diseases—for instance, hyperæmia, cirrhosis, abscess, cancer, and echinococcus. It is often a part of a general peritonitis or may result from an extension of inflammation of the stomach, duodenum, or kidneys. Sometimes in right-sided pleurisy the inflammation may extend through the diaphragm. In cardiac hypertrophy the margin of the left lobe may be affected by pressure.

Curschmann[1] reported a case of perihepatitis in which the upper half of the peritoneal surface of the anterior abdominal wall was covered with a thick, hard, fibrous mass which extended beneath the diaphragm surrounding the liver and spleen. The liver substance when cut was dry and of a brown color. There was not the slightest trace of interstitial inflammation. Similar cases have been reported by Budd, Bright, and Rumpf.[2] Curschmann gave the term "Zuckerguss leber" to this form of disease. The cause of the fibrous perihepatitis was not made out.

Pathological Anatomy.—In the chronic form of fibrous perihepatitis the connective tissue is greatly increased, and strong adhesions are formed between the liver and the neighboring parts, as the diaphragm, walls of the abdomen, stomach, colon, and spleen. The capsule may become so firm and hard that it forms a mould or cavity for the liver which does not collapse when the organ is removed. In such cases the liver is often globular in form. It is sometimes subjected to much pressure, and the inflammation may extend into the hepatic substance, producing a form of cirrhosis. The inflammation may also pass through the hilus along the portal vein, thus causing a very serious obstruction to the flow of blood through the portal system. This may be followed by intestinal hemorrhage, ascites, and other sequences similar to those found in cirrhosis of the liver. Frerichs has described a case of adhesive inflammation of the hepatic vein the result of perihepatitis. The inflammation may also extend along the bile ducts, and obstructive jaundice result therefrom as well as from the direct pressure from bands of adhesions.

[1] *Deutsche med. Wochenschrift*, 1884, S. 564.
[2] *Deutsche Archiv f. klin. Med.*, Mar. 13, 1895.

Symptoms.—In the acute form severe pain is experienced in the hepatic region, which is increased by movement, cough, or pressure. Even the ordinary movements of the thorax are attended with pain, and the respirations are therefore frequent and shallow. The pain may radiate to the right shoulder and may be accompanied by nausea and hiccough. The latter is often a persistent and very distressing symptom. A friction sound can be readily made out in some cases where the inflammation is of limited extent, and a friction fremitus is occasionally present. In a case of hepatic carcinoma recently observed by the writer a friction sound could be readily felt over the liver region, although on post-mortem examination only a few adhesions were found on the surface of some cancerous nodules.

In the chronic form the same signs, as well as increased hepatic dulness, exist. Symptoms of biliary and portal obstruction may be developed.

When the adhesions are extensive and firm the liver will not be changed in position by deep respiratory movements, and the symptoms will resemble those of cirrhosis.

(2) **Pyo-perihepatitis.**—Perihepatic abscess has a clinical history of its own, and should be described in connection with diseases of the liver. In many cases the symptoms of hepatic and perihepatic abscess are so similar that the diagnosis between them presents great difficulty. Perihepatic abscess may be situated above or below the liver. Subphrenic abscesses may be situated on either side of the body, nearly as frequently in the left as in the right hypochondrium, and may thus bear no special relationship to the liver.

We shall describe those which exist in the hepatic region.

Etiology.—Meltzer of New York has recently collected 110 cases of subphrenic abscess, 58 in men and 52 in women: 5 were bilateral, 4 of which were in women. Of the 48 unilateral cases in women, 34 were on the left side and 14 on the right side. In the 54 men, 41 were on the right side and 13 on the left. In 32 cases, 28 females and 4 males, gastric ulcer was the cause. Duodenal ulcer was present in 7 cases, 2 females and 5 males. Of 13 cases of appendicitis, 11 were in men. It will thus be seen that subphrenic abscesses on the right side occur more frequently in men than in women. Abscess on the left side most frequently arises from gastric ulcer, and therefore is more common in women.

Among the most frequent causes are suppurative or ulcerative inflammation in the digestive tract and direct traumatism. In 19 cases recorded by Scheurlein, 3 resulted from traumatism of the hepatic region, 3 from abscess of the liver or suppurating hepatic cyst, 6 from perityphlitis or perforating appendicitis, 4 from simple ulceration of the duodenum, and 3 from simple perforation of the stomach.

This disease may also result from calculous cholangitis, perforation of the biliary passages, ulcerative carcinoma of the pylorus, dysentery with or without perforation, intestinal perforation from typhoid fever, pyæmia, puerperal septicæmia, right pyothorax, and from traumatism.

Pathological Anatomy.—The seat of abscess is frequently on the anterior upper surface of the liver, between it and the diaphragm.

It is often surrounded by a wall of dense adhesions which generally present a dark color. Sometimes a hemorrhage may take place into the cavity, producing a true hæmatoma. The abscess may remain intact for a long time or the pus may burrow into neighboring parts opening into the thorax, lungs, or cavity of the abdomen. The contents of the abscess are frequently tinged with bile or they may present a fetid, stercoraceous, or gangrenous odor. Fetid gas may sometimes develop and penetrate to surrounding parts. The condition of the neighboring structures varies in different cases. The right pleura is often more or less affected in subphrenic abscess, and purulent pleurisy may result; both pleuræ are sometimes affected; the diaphrgam is usually pressed upward and the liver may be displaced downward and inward. Often costo-diaphragmatic adhesions are formed, so that an opening may be readily made through the intercostal space directly into the abscess cavity. The capsule of the liver is altered in structure; it may be inflamed or ulcerated. Sometimes the liver substance may be encroached upon, and an abscess form in the organ itself. Multiple abscesses from suppurative cholangitis may occur secondarily to perihepatic inflammation.

Symptoms.—Suppurative perihepatitis very frequently arises from ulceration and perforation of a neighboring organ, so that there is usually a history of a pre-existing disease either in the stomach or bowels. Pain, one of the most constant symptoms, occupies the hypochondrium. It is severe, deep, and tearing in character, increased by coughing and by the respiratory movements. The patient lies quiet with the decubitus on the back or on the left side; sometimes the body is bent toward the right side to relieve the pressure of the abdominal walls. The respirations are short, superficial, and purely costal in character; the movements of the ribs in the upper part of the right side are less when pleurisy is present; the patient is often troubled with a slight cough, and hiccough of an uncontrollable character is sometimes present, as well as nausea and vomiting. The bowels are generally constipated; a small, accelerated pulse and a remitting fever with evening exacerbations, together with the usual symptoms which accompany the formation of a large abscess, are present.

Subphrenic abscess often forms without marked constitutional symptoms. A case recently came under the observation of the writer which illustrates this fact. The patient, a physician, attended to his usual duties for some days after the appearance of a swelling in the right hypochondriac region; he went to bed on a Thursday, and on the following Saturday the abscess was opened and a large quantity of pus was evacuated.

On physical examination great enlargement of the side is noticed, together with bulging of the ribs in the lower half of the thorax; friction sounds and fremitus are sometimes made out; dulness may extend upward to the fourth interspace and even higher; deep fluctuation is sometimes found, and localized œdema and the presence of lancinating pains over the most prominent point are characteristic symptoms.

Diagnosis.—A puncture with an exploring syringe will often settle the diagnosis. Unless great care is taken this means may fail, owing to the thickness of the walls of the abscess or the density of the pus.

An early diagnosis, although of great value, is often made with difficulty. In some cases conditions which complicate the abscess may be so marked in character that the presence of pus may be overlooked. In a case described elsewhere by the writer an enormously distended stomach and a much displaced liver obscured the diagnosis. The dilatation of the stomach was the result of pyloric stenosis produced by bands of peritoneal inflammation. In all cases of disease in the upper part of the abdominal cavity a careful examination should be made of the posterior part of the thorax to mark the lower margin of the lungs.

The diagnosis between subphrenic abscess and empyema of the right side is usually made without difficulty. A careful examination of the upper portion of the thorax in front and behind will reveal normal pulmonary resonance and vesicular breathing in subphrenic abscess, whereas in empyema marked dulness and the absence of the respiratory sounds are usually noticed. A localized empyema confined to the lower portion of the thorax on the right side is diagnosed with difficulty from subphrenic abscess. The symptoms of subphrenic abscess are usually more severe than those of empyema.

The abscess may open in various directions, and an empyema may exist as a secondary condition.

(3) Pneumo-pyo-perihepatitis.—Etiology.—This disease is distinguished by the presence of gas in the abscess cavity. It usually exists as a sequel of perforating ulcer of the stomach. Pfuhl in 1879 described 3 cases under the heading of subphrenic pneumo-thorax. Leyden published an exhaustive paper on this subject in 1880, entitled Pyo-pneumo-thorax Subphrenicus. Although ulceration of the stomach is the most frequent cause, this condition may also arise from similar ulcerations in the duodenum, cæcum, and appendix. The disease in the walls of these viscera may be of an inflammatory or a malignant character. The gas may arise from direct communication with the latter or from decomposition of pus in the abscess itself—a process, however, which has not yet been demonstrated.

Symptoms.—Two series of symptoms exist in these cases: First, those due to the inflammation and suppuration, such as have already been described; and second, those arising from the presence of gas. The gas produces an enormous swelling in the right thorax accompanied by dyspnœa; dulness may extend as high as the third intercostal space, and the heart may be pushed upward and to the left.

The diagnosis between this condition and pneumo-pyo-thorax is often extremely difficult, and mistakes have been made by the ablest physicians. Leyden gives the following diagnostic points: (1) Previous abdominal symptoms and the absence of thoracic disease in the early part of the illness; (2) little displacement of the heart or bulging of the interspaces; (3) normal respiration under the clavicle, with abrupt transition lower down to the metallic and amphoric sounds, such as occur in pneumo-thorax. In pneumo-pyo-thorax the normal sounds would not be heard in the upper portion of the thorax. Lawrence Mason has remarked in this connection that the heart is often displaced by accompanying pleural effusion, and that the abrupt change in the percussion note is not always found. He also emphasizes the fact that

the metallic sounds may be loudest over the epigastrium in the subphrenic condition. Cases of pneumo-pyo-perihepatitis are nearly always fatal.

The PROGNOSIS is more favorable when it follows perforative appendicitis.

(4) **Tubercular Pyo-perihepatitis.**—The tubercular form may result in a fibrous thickening of the capsule and the neighboring parts, giving rise to symptoms similar to those already described. The introduction of pus organisms will result in a purulent formation in the tubercular mass. In such cases other evidences of tubercular disease, such as osteitis and enlargement of the gland, are noticed. A prominent tumor with a deep fluctuation is usually found above the liver, pressing it downward and inward. The process is similar to that of ordinary pyo-perihepatitis, except that it is not accompanied by as much pain and with less fever.

PROGNOSIS OF PERIHEPATITIS.—In the *dry form* the prognosis is usually favorable. Death results rather from the primary disease than from the condition itself. The writer observed a case of dry perihepatitis in which a fatal result occurred during the acute stage. The patient, who suffered from mitral stenosis, complained of severe pain and tenderness over the hepatic region; there was also an increase of liver dulness, which was largely due to hypertrophy from passive congestion. On post-mortem examination the enlarged liver was found to be bound down by fresh adhesions.

In the *purulent form* the prognosis also depends on the primary condition. According to Mason, the chances of life are very poor in cases which result from perforation of the stomach or duodenum, but they are more favorable when the abscess is connected with the liver, kidney, or vermiform appendix. An examination of the bacteria found in the contents may aid in the prognosis. Where, for instance, the pneumococcus is found, other things being equal, the prognosis is not as grave as when the staphylococcus or the germ of putrefaction is the pyogenic agent.

TREATMENT OF PERIHEPATITIS.—In the *dry form* sedatives may be given to relieve pain, such as morphine by hypodermic injection; leeches or cups may be applied locally, followed by hot fomentations; rest in bed is necessary in any case, but more particularly in those complicated by cardiac disease.

When pus is present, with or without gas, a surgical operation is demanded, and the earlier the operation is performed the better. The great difficulty is to discover the location of the abscess. Cases have occasionally come under my observation where from the history and general condition I was confident of the presence of pus, but was unable to locate it by ordinary methods of exploration. The only resource under such circumstances is to open the abdomen and make a careful search. Although such an operation may be a severe one, it is better to advise it than to allow the patient to die without making any attempt to give relief.

In the *tubercular form* the general treatment for that disease is indicated. The administration of arsenic and creasote has been followed by good results.

THE HEPATIC CIRRHOSES.

THE definite proportion which exists normally between the connective tissue and the hepatic cells may under certain pathological conditions become changed, so that the former is much increased and the latter diminished.

According to Chauffard, whose classification is here given, to constitute a cirrhosis the increase of connective tissue must be generalized. Areas of induration in the neighborhood of tumors, for instance, do not constitute a cirrhosis. Moreover, the increased connective tissue should be largely in the adult state, not embryonal, and the epithelial element becomes slowly but profoundly affected, undergoing degeneration and destruction. This increase of connective tissue is due to the continuous presence of an irritative agent which may vary in character. This agent may be taken into the stomach or may be formed in the body.

Alcohol was at one time thought to be almost the sole cause of cirrhosis, but we now know that many other toxins have the same effect. Although these agents usually reach the hepatic cells through the circulatory system, they may also enter the liver by the lymphatic channels.

In the study of cirrhosis we should first take into consideration the agent, and secondly the evolution of the diseased process. The cirrhoses may thus be divided into three great classes, the vascular, biliary, and capsular:

1. *Vascular Cirrhosis.*

(*a*) Toxic form, { Poisons taken into the stomach; Autochthonous poisons.

(*b*) Infection form, { By direct action of microbes; By toxic infection, { local, extra-hepatic;

(*c*) Distrophic form, { Arterio-sclerosis; Subhepatic stasis.

2. *Biliary Cirrhosis.*

(*a*) The hypertrophic cirrhosis of Hanot; (*b*) Calculous cirrhosis.

3. *Capsular Cirrhosis.*

(*a*) Chronic localized perihepatitis; (*b*) Chronic generalized perihepatitis.

1. Vascular Cirrhosis.

(*a*) Toxic Form.—*Poisons Taken into the Stomach.*—Of all poisons which are taken into the stomach, the most frequent cause of cirrhosis is alcohol. Lallemand and Duroy in 1860 calculated the proportionate amount of alcohol found in the different organs of those who had taken large quantities. One part was found in the blood, two parts in the brain, and four in the liver, thus confirming the generally accepted

view that the liver of all organs in the body is the most seriously affected.

Dujardin-Beaumetz has shown that the toxicity of alcohols is in direct proportion to their molecular weights and boiling points. Thus ethylic is very much less poisonous than amylic alcohol. The oils of wine have been shown to be exceedingly toxic and to have a very irritative action on the connective tissue of the liver.

Experiments have been made by introducing alcohol in various forms into the stomach of rabbits and noting the effects on the liver. De Rechter[1] in a series of experiments on dogs and rabbits introduced into the stomach a liquid made up of 225 parts of absolute ethylic alcohol, 2.5 parts of amylic alcohol, and 75 parts of water. Interstitial sclerotic changes were produced in the liver without alteration of the parenchyma. On the other hand, in a series of experiments conducted by Lafitte the hepatic cells seem to have been the seat of pathological change. Strauss and Blocq found the connective tissue infiltrated and hypertrophied.

Lead, probably, next to alcohol, is the most frequent agent which when taken into the stomach produces cirrhosis. Lafitte was able by giving it in food to produce cirrhosis in rabbits. Lancereaux has observed in copper-workers an anthracotic form of cirrhosis quite similar to the condition of the lungs in pneumonokoniosis. Eichhorst has recorded a case of hardening and nodulation the result of the ingestion of phosphorus. Bouchard mentions naphthol as an agent. Anthracotic cirrhosis from the presence of particles of carbon might come under this class.

Segers[2] has recently described a curious form of chronic intoxication which is found among the inhabitants of Terra del Fuego from the ingestion of mussels. This produces, first, an hypertrophy of the liver with jaundice, which is after a time followed by atrophy and hemorrhages. A poison has been found in the liver of the mussel which acted very quickly in the dog and in the rabbit.

Budd was of the opinion that the frequent occurrence of cirrhosis in India might be due to the ingestion of highly seasoned food, as curry and other irritating spices.

Autochthonous Poisons.—Cirrhosis is a condition sometimes found in gout and diabetes. In these diseases it is difficult, however, to exclude the possible agency of alcohol, as both gout and diabetes frequently occur in patients who have been addicted to excessive indulgence in spirits. As a proof of the direct agency of autochthonous poisons in the production of cirrhosis might be mentioned the experience of Ebstein, who found crystals of hypoxanthin and other extractive matters in the connective tissue in a case of hypertrophic cirrhosis.

The pathological changes in the liver in diabetes will be considered here, although reference will again be made to a pigmentary cirrhosis sometimes found in this disease. These changes have been described by Frerichs, Klebs, and others. The organ is at first uniformly enlarged, the margin rounded, and the consistence normal. The increase in size is due to a greater amount of blood in the vessels and enlarge-

[1] *Bulletin de l'Académie royal de Belgique.* [2] *Sem. méd.*, 1891.

ment of the hepatic cells. The latter are somewhat rounded, with contents slightly cloudy and with a large and distinct nucleus. The amount of glycogen in the cells varies and is sometimes much increased.

In the more advanced stage the liver cells are not so much swollen and exhibit some fatty degeneration. Stockvis is of the opinion that the enlargement of the liver in diabetes is due to a new formation of secretory cells. The presence of cirrhosis of a marked degree in connection with diabetes has not been frequently noted. A case was reported by Budd[1] in which he described the liver as small, with the lobules shrunken. Trousseau and Frerichs have reported similar cases.

On the other hand, a careful examination of the liver in a large number of cases of diabetes did not reveal any increase of connective tissue; and when all other possible causes of cirrhosis are excluded scarcely a case of that condition in diabetes has been recorded except the pigmentary form.

A condition of cirrhosis may exist in gout as a part of the sclerotic changes which are found in the arteries, kidneys, and other portions of the body. Murchison was of the opinion that alcohol produced cirrhosis more easily in a gouty patient. Scudamore and Trousseau have described a gouty hepatitis.

An enlargement of the liver occurs in rickets, in which there is an increase of fibrous structure surrounding the lobules. There is also a marked thickening of the walls of the bile ducts, with increase of the biliary canaliculi—a condition not unlike that found in hypertrophic cirrhosis. A catarrhal cholangitis is frequently present.

Emil Boix of Paris has recently published a work on *The Liver of Dyspeptics*, in which he relates the histories of cases of cirrhosis caused by dyspepsia, and gives the results of experiments on animals. He concludes that the enlarged liver of dyspepsia, when temporary, is a hepatic congestion, and when permanent it may be a true cirrhosis.

(*b*) **Infection Form.**—*By Direct Action of Microbes.*—Podwyssozki is of opinion that coccidia are sometimes a cause of cirrhosis. They lead to destruction of the hepatic cells, and in this way, as well as by acting as irritants, they cause a form of interstitial hepatitis. It is probable that in many of the infectious diseases—tuberculosis, for instance—micro-organisms peculiar to these affections lodge in the liver and by their presence set up an interstitial inflammation.

The infectious diseases in which cirrhosis is most frequently found are syphilis, tuberculosis, and malaria. It is probable that the irritating agent in some cases is the microbe itself; in others a poison produced locally; but in the majority the toxin which acts on the liver is formed in other parts of the body.

In 63 cases of cirrhosis in children collected by the late Palmer Howard, syphilis, chiefly hereditary, was found in 11 per cent., and tubercular disease was found in other organs in about the same proportion. In 36 cases recorded by Frerichs malaria was the cause of the cirrhosis in 14 per cent. Cantani has demonstrated the agency of malaria in the production of cirrhosis. Cholera, typhus, and typhoid fever have been recognized by Botkin as causes of cirrhosis, as well as scarlet fever, variola, and measles.

[1] *Diseases of the Liver*, 3d ed. p. 310.

In the 63 cases already mentioned as reported by Howard, after those arising from syphilis, tuberculosis, and alcoholism had been excluded, quite a large number remained in which the origin could not be explained. They might have been produced by toxins remaining in the blood after typhoid fever, measles, and scarlatina.

With regard to the question of toxins causing cirrhosis, Flexner of the Johns Hopkins Hospital made an experimental study of the pathological changes caused by certain so-called toxalbumins. He injected a 1 per cent. solution of dog's serum twenty-four hours' old into the veins of two rabbits. The first animal operated on died in twenty minutes, but the second survived. After the lapse of thirty minutes hæmoglobin casts were found in the urine. For some days the animal seemed quite well, but after the first week it began to lose weight, became emaciated, and died about the end of the second week. At the autopsy the liver was firm in consistence, roughened externally, and dark in color. On microscopical examination the chronic changes "were such an accurate reproduction of cirrhosis in human beings that a separate description seems superfluous." Flexner remarks, in conclusion: "The study of the tissue changes that I have had the privilege of bringing before you has brought us from the consideration of acute degenerative changes of a focal character due to soluble poisons to the realization of the probability of their playing an important part in the production of chronic interstitial changes in animals, which find in cirrhosis of the liver and chronic nephritis analogues in human beings." From these experiments, as well as from clinical observation, it would appear that toxins play an important part in the production of cirrhosis.

Then the fact that interstitial hepatitis is not a frequent condition in those who take alcohol to excess—it not having been found in more than 4 per cent. of all cases—would lead to the conclusion that in those individuals in whom alcohol produces an atrophic cirrhosis a predisposition exists to that disease. This predisposition may be the result of a previous infectious disease.

(*c*) **Dystrophic Form.**—Among the dystrophic varieties of cirrhosis might be mentioned the senile form, found in patients over forty-five years of age. This is often associated with arterio-sclerosis and endarteritis. Occasionally cirrhosis combined with similar pathological changes in the arteries occurs in comparatively young subjects. In some cases a sclerosed condition of the kidneys may be found.

A case of calcified cirrhotic liver has been described by Taggert.[1] It occurred in an old man in whom calcification followed cirrhosis. The liver could not be cut with a knife and a saw was used in making sections.

2. Biliary Cirrhosis.

Cirrhosis the result of the retention of bile is usually attended by very intense jaundice. Osler doubts that simple retention of bile and dilatation of the bile ducts can produce interstitial hepatitis. This form is to be distinguished from the hypertrophic cirrhosis of Hanot. The clinical and pathological differences will be given in detail farther on (p. 507).

[1] *Trans. Lond. Path. Society*, 1889.

In hypertrophic biliary cirrhosis the hardening results from a systematic process of cholangitis and pericholangitis in which the biliary radicles are involved.

3. Capsular Cirrhosis.

Capsular cirrhosis may exist secondarily to a chronic exudative perihepatitis. It may also arise from the perihepatitis of tubercular and syphilitic origin, as well as from that form which accompanies passive congestion of the liver from dilatation of the heart. In occasional cases in right-sided pleurisy the inflammatory process may extend downward, producing a perihepatitis which may lead to more or less cirrhosis. Bassi has shown that in some forms of perihepatitis the microbes and toxins may be absorbed by the lymphatics of the liver. In many cases of cirrhosis the agents may be multiple, and the same class of agents does not always act in the same way.

Alcoholic Cirrhosis.

The term alcoholic should not be considered as synonymous with atrophic in speaking of cirrhosis. While in perhaps the majority of cases of interstitial hepatitis the result of alcohol there is decided atrophy, cases very frequently occur in which on account of fatty infiltration the liver may be normal in size and even hypertrophied. This is sometimes termed a venous cirrhosis in contradistinction to the biliary form.

Etiology.—Cirrhosis is a disease of middle life, and is usually the result of many years' indulgence. In 31 autopsies made in Virchow's laboratory 20 were between the ages of thirty and sixty, and 11 between forty and fifty.

Alcoholic cirrhosis has been found from time to time occurring in children. In Palmer Howard's 63 cases of all varieties, alcohol appeared to be the cause in 15 per cent. Hebrard[1] found that in 51 cases of infantile cirrhosis 7 were due to the abuse of alcohol. Barlow has described a case of hobnailed liver in a child who had been fed on beer and gin. Death took place when the child was eighteen months old.

Drinking spirits, especially shortly before meals, is the form of indulgence which most frequently leads to cirrhosis. In a large number of cases it will be found on close inquiry that the patient has taken spirits habitually before breakfast. Wine and beer produce the fatty form of cirrhosis in those of sedentary habits more than in those who are active.

In a case of pulmonary tuberculosis complicated with cirrhosis of the liver which the writer recently observed the patient had been a very moderate drinker, except during a period of three months in the previous year, when he took an excessive quantity of alcohol, drinking often before meals. The hepatic condition could not be ascribed to any other cause.

The disease, as a rule, occurs more frequently in those who live in cities than in the inhabitants of country places. Allison reports that in

[1] *Thèse de Lyon*, 1886.

254 alcoholics who lived in the country cirrhosis was found in 1 in every 85, whereas in 244 laborers in the city the proportion was 1 to 34, and of 75 city residents whose occupations were of a sedentary character it was 1 to 25. Alcoholic cirrhosis is especially prevalent among publicans and sailors, and is often found among those predisposed to gout.

Chauffard and other French writers are of the opinion that the vapor of alcohol entering the body through the respiratory organs may assist in causing cirrhosis, and mentions as a proof the frequency with which the disease occurs in those who work in distilleries and wine-cellars.

Pathological Anatomy.—Alcoholic cirrhosis of the liver exists in two principal forms—the atrophic form, or cirrhosis of Laennec, and the fatty, or, as it is sometimes called, the fatty hypertrophic form. The latter must be distinguished from the biliary or hypertrophic cirrhosis with chronic jaundice of Hanot, which will be subsequently described (page 507).

The appearance of the liver in the atrophic form will depend on the stage of the disease.

In the first stage the connective tissue is increased in amount and the whole organ is larger than normal, whereas in the second stage, owing to contraction of the connective tissue, the liver becomes atrophied and its surface roughened. It is not known whether the liver always undergoes the first stage of enlargement or not, but it certainly exists in some cases. As Eichhorst states, this division is made merely for the purpose of more easy description. As a matter of fact, both changes may go on at the same time, and it is very difficult to draw a line between them. In the first the liver is enlarged and is slightly if at all roughened: there is, however, greater density of the whole organ. Upon section the resistance is greater than normal, and the cut surface shows an increase of connective tissue which separates the lobules from one another. In a more advanced stage the connective tissue is found invading the lobules and destroying the cells nearest the periphery. The hardness of the liver is due to the increase in the connective tissue. Jaccoud has described some cases of perivenous cirrhosis in which the hypertrophy persisted throughout the disease.

On post-mortem examination the liver is, as a rule, found in the second stage of cirrhosis. It is diminished both in volume and in weight, and often weighs not more than 1000 grammes instead of from 1500 to 2000 grammes. The specific gravity is increased. The form is irregular, and the organ is often attached to surrounding parts by bands of perihepatic inflammation. The contraction is greater in the left lobe, which is often so atrophied as to be scarcely distinguishable. The surface is roughened, presenting warty elevations varying in size, which give to the liver that peculiar hobnailed appearance so well described by the older writers. This condition is the result of contraction of the connective tissue, pressing out portions of the liver substance in the direction of least resistance. The capsule is thickened in the furrows between the lobules. The organ is tough and inelastic, presents a brown or grayish color, a leathery feel, and on section is hard and cartilaginous. The cut surface has a hard, fibrous appearance, and exhibits the presence of two different structures, the one grayish in

color and rich in vessels which form a series of rings of unequal size, and the other glandular, reddish yellow, often light yellow, filling in the spaces of the fibrous portion. The term cirrhosis was first given by Laennec on account of the light yellow appearance of the cut surface. In many parts the glandular substance of the liver disappears and is replaced by connective tissue. Upon injection of the portal veins we find obstruction of the smaller branches, whereas the hepatic artery can usually be injected with ease. The portal veins become closed as the result of thrombosis and phlebitis. In the later stages the biliary radicles become obstructed, so that jaundice is a frequent symptom. The amount of obstruction in the portal vein, as well as that met with in the biliary ducts, varies much in different cases. In the stage of development the connective tissue presents the ordinary appearances of subacute inflammation, being made up of round and spindle cells with white fibrous tissue. It is often markedly increased, and round cells are present, particularly in that part which is contiguous to the portal vessels as well as to the walls of the smaller veins. The new fibrous structure is derived partly from pre-existing tissue and partly from hepatic cells. The transformation of hepatic cells into connective tissue is thus described by Hamilton: "The liver cells have already been described as often dividing in a remarkably active manner, the protoplasm becoming smaller and smaller with each segmentation. There arrives a time when the protoplasm surrounding the nucleus has almost vanished, while the nucleus remains of great size. At this stage the cell seems to elongate into a nucleated spindle whose ends split up into the fibrils of a bundle of fibrous tissue." In a small number of cases the fibrous tissue surrounds each lobule, whereas in the majority several lobules are included within a thick band of tissue. The pressure from the contraction of the surrounding tissue produces degeneration and destruction of the cells which are on the outer margin of the lobule. The nutrition of the cells is also interfered with by the blood supply being cut off, owing to closure of the smaller branches of the portal vein.

The changes in the liver cells are thus not all of the same character. Some become simply atrophied, whereas others are transformed into connective-tissue cells in the manner already described.

In the latter part of the second stage the amount of connective tissue is very much increased, with greater or less destruction of the true glandular structure. Some lobules have entirely disappeared, while masses of pigment of a brownish color are all that are left of others. In the lobules which remain connective tissue is found between the liver cells. Regenerative changes are frequently noticed. A regeneration of the hepatic cells probably takes place in some cases. Small biliary passages are often found in the connective-tissue bands, but not to the same extent as in biliary cirrhosis.

Adenomata occur in some cases of cirrhosis, as was first shown by Rindfleisch. They may be found in large numbers and vary in size from a lentil to a hazelnut, and frequently modify the appearance of the diseased organ.

The changes described are thus classified by Ziegler: (1) small-celled infiltration; (2) increase of connective tissue; (3) atrophy of liver

tissue; and (4) increase of bile ducts. In the fatty form of alcoholic cirrhosis the fatty infiltration takes place previous to the increase of connective tissue. The liver may be normal in size or may be much enlarged. The surface is smooth or slightly roughened and yellowish white in color. The consistence is firm, and the cut surface presents an increase of connective tissue and a fatty infiltration of the liver cells. This form occurs more frequently in beer and wine drinkers, and Osler states that it is quite as frequently met with in this country as the atrophic variety. In some cases amyloid infiltration may have existed previous to the cirrhosis, and the liver may on this account be increased rather than diminished in size.

Pathological changes found in other parts of the body are usually secondary to those which exist in the liver. Obstruction of the portal circulation results in a passive congestion of the mucous membrane of the digestive tract as well as of the vessels of the peritoneum. The portal vein may be very much dilated and present evidences of endo- and periphlebitis. The veins in the lower end of the œsophagus are often dilated, and are sometimes the seat of fatal hemorrhage. Garland of Boston has recently reported a case.

The peritoneal cavity, as a rule, contains a large quantity of transparent fluid, sometimes stained with the coloring matter of the blood. Extravasations of blood frequently take place beneath the parietal layer. Thrombi are sometimes found in the larger vessels, and there is always more or less evidence of chronic peritonitis, and the mesentery is frequently retracted. The mucous membrane of the stomach and intestines presents the appearances of chronic catarrh as well as those of passive congestion. The catarrh arises directly from the ingestion of alcohol. Occasionally extravasations of blood are found in the deeper portions of the mucous membrane as well as beneath it. A diminution in the length of the intestine has been noted by Bright, and has recently been confirmed by Gratin. The diminution is greater in the older and more pronounced cases, and in such cases the walls of the intestine are thickened.

The spleen is enlarged to one and a half to three times its normal volume, and the vessels in it are dilated and to some extent formed into sinuses. The cut surface shows an increase of connective tissue.

The kidneys are often congested, and occasionally present signs of parenchymatous inflammation. Interstitial nephritis is, however, more frequently found. According to Price, it exists in 17.5 per cent. of all cases of hepatic cirrhosis.

The walls of the heart show evidences of fatty degeneration. Endocarditis, pericarditis, and pleurisy are not infrequent complications. Cardiac incompetency is occasionally met with and may be the cause of general anasarca. The heart is frequently pressed upward by the large amount of fluid in the peritoneal cavity.

Acute tuberculosis of the peritoneum has been referred to by Osler. In 22.5 per cent., of the cases of cirrhosis in which post-mortem examinations were made in Guy's Hospital evidences of tuberculosis were found. Broadbent speaks of a catarrhal œdema of the lungs in connection with cirrhosis.

Pathology.—We do not yet quite clearly understand the earliest

changes which take place in the process of cirrhosis. It has generally been believed that irritants act directly upon the connective tissue, producing a chronic inflammation, followed by contraction and death of the hepatic cells through pressure. More recently many pathologists entertain the opinion that the irritant acts directly on the hepatic cells, causing their destruction, and that the increase of connective tissue is a secondary process. It is, however, probable that the connective tissue is the primary seat of inflammation, and, as before stated, the destruction of hepatic cells results partly from a cutting off of the blood supply by venous thrombosis. The fact that the earliest signs of inflammation are found close to the interlobular vein is strong evidence that the irritant circulating in the blood affects the connective tissue directly. The changes in and around the interlobular veins end in closure of the latter either by pressure, thickening of the walls, or thrombosis. A dilatation of the portal vein and all its branches outside of the liver then takes place. The obstruction to the circulation results in a passive congestion of the mucous membrane of the gastro-intestinal tract, of the vessels of the peritoneum, as well as enlargement of the spleen.

A rupture of a vessel of the stomach or bowels may cause severe hemorrhage. The stomach is the usual seat of rupture, and the vessels near the cardiac orifice most frequently give way.

Chronic mucous catarrh and extravasation of blood into the tissues also result from portal obstruction. These conditions are more severe and extensive when the onset is rapid and when the changes take place in the liver quickly. If the process of atrophy is slow, time is given for the development of a collateral circulation which to some extent delays the changes in the abdomen. This collateral circulation is maintained in many ways which are very succinctly described by Osler.[1]

1. The accessory portal circulation, as described by Sappey and more recently investigated by Baumgarten, is carried on by vessels which pass through the round and suspensory ligaments and communicate with others in the walls of the abdomen. A large vein is sometimes found passing from the hilus through the round ligament connecting with an epigastric vein at the umbilicus. This has been described as a parumbilical vein by Sappey. The Rest-kanal of Baumgarten is a vessel remaining after obliteration of the umbilical vein through which blood passes in the adult from the liver to the umbilicus. The circulation in the Rest-kanal is carried on by means of small branches which communicate with the gastric veins. Baumgarten has thus demonstrated the fact that the umbilical vein does not close completely in some cases, and may become much distended in cirrhosis. Branches of the same system increase in number and size in the suspensory ligament, walls of the gall bladder, and the gastro-epiploic omentum. The caput medusæ is formed beneath the integument in the epigastric region. Both Baumgarten and Sappey state that in some cases a slight fremitus may be noted on palpation, and sometimes a slight bruit on auscultation.

2. Anastomosis between the œsophageal and gastric veins by which the blood passes into the vena azygos. Veins in this region are much dilated and sometimes rupture, resulting in severe hemorrhage.

3. Communication between the inferior hemorrhoidal and hypo-

[1] *Practice of Medicine*, p. 476, 2d ed.

gastric veins. Sappey and Frerichs have pointed out the fact that, although this would appear to be a very important channel in cirrhosis, the anastomosis is not at all marked.

4. The veins of Retzius, through which the blood is returned from the portal vessels of the intestines and mesentery into the branches of the inferior vena cava.

Notwithstanding all these means of communication the portal obstruction becomes more or less complete, and the patient may die from hemorrhage, from exhaustion the result of frequent tappings, or from the diseased condition of the gastro-intestinal mucous membrane.

Symptoms.—The early symptoms of alcoholic cirrhosis are, as a rule, indefinite, and in many cases a diagnosis cannot be made until after the appearance of fluid in the peritoneal cavity. It is difficult to distinguish between the symptoms due to the condition of the liver and those arising from gastro-intestinal catarrh so often found in alcoholic subjects. The lesion may exist for months without being even suspected. This is proven by the frequent discovery of incipient cirrhosis in the post-mortem room in cases where no history of the disease had been given during life. The early symptoms are mucous and bilious vomiting, especially in the morning, nausea after eating, coated tongue, and bitter taste in the mouth. There is a feeling of emptiness and craving for food, which when taken even in small quantities produces nausea and pyrosis. Constipation alternating with diarrhœa is frequently noted. The patient becomes pale, thin, and easily fatigued. The face often presents numerous capillary varicosities. A dull, heavy pain exists in the hepatic region which radiates toward the right shoulder. Tenderness is experienced, over the liver, and is increased at times when there is greater hyperæmia. In the early stage the liver may be larger than normal and the anterior border may be felt below the costal line. When atrophy occurs the area of hepatic dulness is diminished—a point which is not easy to determine. This difficulty in marking out the liver dulness may arise from tympanitic distention of the stomach and bowels, particularly the transverse colon. A portion of the stomach or intestines may become interposed between the liver and the walls of the abdomen, or the liver may be pushed upward so that its anterior border does not come in contact with the abdominal walls. Enlargement and tympanites are most prominent at first in the subumbilical region. The anterior surface may be sometimes felt through the walls of the abdomen, and a friction sound may be heard on auscultation in forced respiration. A friction fremitus has also been noticed.

The urine is scanty and high colored, orange or brown. At the onset of the disease it may be increased in quantity. Sugar is sometimes present, and is increased if a saccharine or starchy diet is indulged in.

Ascites.—The onset of ascites is very insidious, and attention is often drawn to it by the clothing becoming too tight, especially after meals. This, together with the dyspeptic symptoms already mentioned, will often lead the patient to consult a physician. In many cases, according to Hanot, a peritonitis is the determining cause of the ascites, in the same way that a hydrothorax in cardiac disease is preceded by a

slight pleurisy. Cases of acute cirrhosis occur in which the early premonitory symptoms are severe and the abdomen soon becomes filled with fluid. The amount of ascitic fluid varies greatly in different cases, and has been found to be as much as ten or fifteen litres. The abdomen is usually oval or almost globular in shape, flattened at the front and bulging at the sides. Examination of the liver by palpation is under these circumstances difficult. Its surface may be felt by sudden pressure with the fingers (dipping for the liver). Enlargement of the spleen, though present, may be difficult to demonstrate. The hypertrophy is not in proportion to the amount of obstruction, and depends on a diffuse hyperplasia of the splenic tissue. A splenic souffle has been described by Bouchard. Martini[1] has described 3 cases of cirrhosis of the liver with enlarged spleen in which a continuous souffle, increased during inspiration, was heard in the sixth intercostal space at the right anterior axillary line. Nothing was found in the post-mortem examination to account for the limit. The author was of opinion that the souffle was caused by a displacement of the inferior vena cava.

The presence of fluid in the abdomen is shown by fluctuation and by change in the area of dulness when the patient assumes different positions. When the patient is lying on the back a circle of tympanites is noticed in the umbilical region, caused by the intestines floating on the surface of the ascitic fluid and thus coming in contact with the walls of the abdomen. Marked dulness is then noticed in the flanks, and when the patient turns to the right the dulness in the left flank is changed to a tympanitic note, and *vice versâ*, unless the intestines are bound down by adhesions. The fluid itself when drawn off presents a clear citron yellow color and varies in density from 1012 to 1016, with alkaline reaction. It contains globulin and serin, as well as a small quantity of sugar, urea, urobilin, alantoin, and cholesterin. When ascitic fluid once appears it remains in greater or less quantity throughout the disease. It is sometimes diminished by treatment or by the anastomosis becoming more complete. In some cases there is no peritoneal fluid.

Parallel with the development of ascites, a very constant sign is the distention of the subcutaneous abdominal veins through which the blood returns from the hypogastric region. These are more prominent on the right than on the left side. A number of dilated capillaries may appear along the margin of the ribs as well as around the umbilicus, forming in the latter case the caput medusæ. The extent of the venous dilatation is generally in proportion to the amount of ascites present.

During the ascitic stage the urine is scanty, partly owing to the reduction of the pressure in the abdominal aorta. The specific gravity is high, the reaction is very acid, and the color orange, with a thick sediment of urates. The amount of urea is diminished and the urobilin and uric acid increased. Murchison has expressed the opinion that the presence of clear urine free from sediment is a strong diagnostic point against cirrhosis. Peptonuria and occasionally glycosuria are present. When the quantity of urine is much below the normal general symptoms

[1] *Gazetta delgi Ospidali*, Naples, Feb., 1894.

of toxæmia may arise, as headache, diarrhœa, bilious vomiting, delirium, and dryness of the tongue. Albumin is sometimes present in small quantities, the result of passive congestion and cachexia. When casts are found they indicate the presence of nephritis unless there is intense jaundice. Semmola has demonstrated a constant inverse ratio between the amount of urea and of the urobilin eliminated.

The amount of jaundice in cirrhosis is very variable, and is usually not marked until late in the disease. It usually arises from catarrhal cholangitis or from compression of the ductus communis choledochus by external adhesions, and not from pressure in the liver. Some cases terminate fatally after the onset of malignant jaundice.

Hemorrhage occurs to a greater or less extent in the majority of cases. Epistaxis is quite frequent, especially in the earliest stages, and some say that the hemorrhage takes place more often from the right than from the left nostril. The gastro-intestinal mucous membrane is the structure from which bleeding is most likely to occur. Hæmatemesis is often so great as to produce a fatal result. The seat of the latter is frequently in the dilated veins near the cardiac orifice, and sometimes from a varix in the lower extremity of the œsophagus. When the blood flows into the stomach it may pass through the pyloric orifice and be discharged through the bowels. Hæmatemesis frequently takes place before the onset of ascites, and is often the first symptom which directs attention to the condition of the liver, the patient having previously enjoyed fair health. It is not always a bad sign, as the portal circulation may in this way be relieved and accumulation of fluid in the peritoneal cavity delayed. For this reason ascites has not been prominent in many cases in which there was severe hemorrhage.

The affection is not of itself attended by fever except in some acute cases, but elevation of temperature may be caused by attacks of perihepatitis or from catarrhal affections of the bile ducts.

Respiration is embarrassed by the distention of the abdomen from gas and peritoneal fluid.

The general nutrition is affected in proportion to the severity of the disease and the length of time during which it has been in existence. The skin is first anæmic, and presents a pale yellow color, and may become jaundiced. The emaciation of the face and chest, as well as of the upper and lower extremities, when compared with the large size of the abdomen, presents a very characteristic picture of cirrhosis. In the later stages the lower extremities frequently become œdematous, the result of direct pressure of fluid on the abdominal veins, of weakness of the myocardium, and of pressure on the pars hepatica of the inferior vena cava from surrounding adhesions.

The other organs of the body are subject to functional disturbances. The action of the heart is often weak, the pulse is of low tension, and the right ventricle is liable to distention. The heart is often displaced upward by the pressure of the fluid in the peritoneal cavity, so that the apex beat is found in the fourth and sometimes even in the third interspace. There is a tendency to congestion of the lungs, and râles are often present at the base of the right lung. Right-sided pleurisy with serous or sero-sanguineous exudation frequently occurs. False membranes of the pleura are sometimes found thick and rich in vessels.

The digestive functions are always profoundly affected. Eructations of gas, pain in the stomach, nausea, and vomiting are frequent symptoms. Diarrhœa alternates with constipation, and the fecal discharges are often of a very fetid character.

Death from asthenia is the usual termination after repeated tappings of the abdomen. Auto-intoxication and hepatic uræmia, as shown by the presence of headache, myosis, scanty urine, delirium, coma, and subnormal temperature, are the precursors of a fatal result. These latter symptoms are sometimes accompanied by increase of bile pigment in the urine.

Microbic biliary infection may be a cause of death, and malignant jaundice with rapid parenchymatous degeneration has also been noticed.

Complications.—Granular degeneration of the kidneys is a frequent complication, as it arises from the same cause, chronic alcoholism. The presence of this condition is manifested by albumin in the urine and general anasarca. Degeneration of the myocardium is also produced by alcohol, and is frequently the cause of the œdema in the later stages of cirrhosis.

Chronic inflammation of the brain membranes occurs in some cases of cirrhosis. The hemorrhagic form of internal pachymeningitis is occasionally found. These conditions also result from long-continued spirit-drinking. Emphysema is sometimes found. Diabetes is rarely met with. There is a tendency to acute inflammations, as pneumonia, bronchitis, pericarditis, and peritonitis.

Among the complicating conditions of the liver itself may be mentioned fatty and amyloid degeneration and thrombosis of the portal vein. Cholelithiasis is not a frequent complication, as was first pointed out by Budd. Cases of cancer abscess and echinococcus have been reported.

The peritoneum is frequently invaded by the bacillus of Koch, and a tuberculosis may develop secondarily to the cirrhosis, as shown by Lancereaux, Render, and E. Wagner. This may occur when there are no tubercular ulcers in the intestines. When this takes place the abdomen often becomes tender on pressure and the patient suffers from colicky pains. Sometimes this condition is accompanied by constitutional symptoms of tuberculosis, vomiting, diarrhœa, hectic fever, profuse sweating, and rapidly increasing marasmus. Pulmonary tuberculosis may also be present.

Course and Duration.—In uncomplicated cases the duration of cirrhosis is usually from one to two years. Patients may be prematurely cut off by hemorrhage, pleurisy, broncho-pneumonia, or tubercular peritonitis.

An acute form of cirrhosis has been described by Hanot and Debove which does not last longer than from four to six months, in which the following symptoms are present: acute febrile disturbance, abdominal pain, early ascites, and cachexia. Submucous and subserous hemorrhages occur in the later stages, followed by subnormal temperature and coma.

Red Atrophy.

The term red atrophy has been used by certain English writers to designate an acute form of alcoholic cirrhosis which is to some extent

allied to acute yellow atrophy. It must be remembered that German writers sometimes use the same term as synonymous with nutmeg liver.

In the red atrophy of the English writers the liver is much reduced in size and the liver cells present an advanced stage of necrosis. Parts of the organ are of a deep red color, and are made up of connective tissue and deeply engorged capillaries, leucocytes, and newly-formed fibrous tissue.

The following case, reported by Carvington,[1] illustrates this peculiar form: The patient was admitted into Guy's Hospital Nov. 13, 1884. He had for the previous six weeks been in the habit of drinking eight pints of beer each day as well as a moderate amount of whiskey. There was no history of gonorrhœa or syphilis. He felt well until two weeks before admission, when he was suddenly seized with a tremor of the hands and a feeling of intense weakness. The conjunctivæ became slightly yellow. The patient when in the hospital suffered from intense nausea and almost continuous vomiting. The urine which the patient passed involuntarily was at first free from bile pigment, but afterward a trace was found. He became delirious and had several epileptiform convulsions, and died suddenly after a severe seizure. The liver weighed thirty-three ounces. The surface was smooth in some places and wrinkled in others.

Microscopical Appearances.—In the yellow portion the hepatic cells were normally arranged and contained granular protoplasm. The red part was largely made up of distinct nuclei. An increase of fibrous tissue was found around the portal vein and new duct "formations" were visible.

Red atrophy is therefore an acute process in which the hepatic cells undergo rapid destruction not unlike that which occurs in acute yellow atrophy, and the hypertrophy of the connective tissue is not so marked, owing to the short duration of the disease.

As has been already mentioned, in some cases of advanced cirrhosis the hepatic cells undergo a similar acute degeneration.

Fatty Cirrhosis.

The symptoms of fatty cirrhosis are similar to those already given. In many cases, however, the disease runs a latent course, and the condition is found in post-mortem examinations when it had not been suspected during life.

Diagnosis.—When an individual who has been addicted to excessive indulgence in alcoholic beverages, and who has for some time suffered from symptoms of gastro-intestinal catarrh, shows signs of the presence of fluid in the abdominal cavity, the presumption is that cirrhosis of the liver is present. A physical examination may reveal diminished hepatic dulness and the presence of a rough, nodulated surface. It may not be possible to obtain any positive knowledge of the latter until after the withdrawal of the ascitic fluid.

Thierfelder gives the following as the important diagnostic symptoms: "Ascites unaccompanied by œdema of the lower extremities or

[1] *Trans. London Pathological Society*, vol. xxxvi. p. 221.

appearing previous to the latter lesion, enlargement of the spleen, diminution in the size of the liver, and cachexia."

The conditions which alcoholic cirrhosis of the liver is more likely to be mistaken for are—adhesive pylethrombosis, diffuse chronic peritonitis, amyloid infiltration, carcinoma and syphilis of the liver, cirrhosed cardiac liver, and simple atrophy from marasmus.

Pylethrombosis may be differentiated by the sudden onset of the ascites, its rapid increase and speedy return after tapping. Hemorrhage from the stomach and bowels may also occur. The cause of the thrombosis, tumors, gall stones, or ulcerations in the portal system may be made out by a careful study of the history and by physical examination. There is no change in the size of the liver and the history of alcoholic indulgence may be absent.

The diagnosis from chronic *diffuse peritonitis*, especially the tubercular form, is often difficult. In this condition the amount of fluid may be very great and it may appear gradually, as in cirrhosis. The spleen may be enlarged and the abdomen may not exhibit any tenderness. The differentiation is made by the absence of a history of alcoholic indulgence, pallor of the skin instead of a yellowish white tint, the history of exposure to tubercular infection, and the presence of hard, tubercular masses floating in the abdominal cavity. The fluid drawn off may contain small particles of tubercular matter or it may contain blood, and is often not as transparent as that of ascites. In some cases of tubercular peritonitis the fluid may disappear and reappear without any apparent cause. Two cases have come under the writer's observation in which this occurred, and in both tuberculosis of the peritoneum was found when an exploratory incision was made. This does not takes place in cirrhosis except as the result of treatment. Tubercular peritonitis is generally, but not always, accompanied by fever, and there may be manifestations of disease elsewhere. A careful physical examination of the liver after tapping is of service. It must be remembered that tuberculosis of the peritoneum is not an infrequent complication of cirrhosis. The diagnosis from diffuse hepatic carcinoma is given on page 561.

Cancerous peritonitis may be distinguished by the presence of pain and tenderness and the occurrence of cancer in other parts of the body, as well as by the peculiar cachexia. The signs of obstruction of the portal vein, the prominence of the abdominal vein, and hemorrhoids may not be present in either tuberculosis or cancer. The ascitic fluid may be stained with blood in both of the latter conditions.

Syphilitic liver is differentiated by the presence of much larger nodules, by tenderness in the right hypochondrium, and by the history of syphilis.

In *atrophic nutmeg liver* the ascites is not an early sign, but appears late in the disease. Cardiac incompetency and obstruction to the pulmonary circulation will be present.

The *simple atrophy of marasmus* may be distinguished by its being uniform, by atrophy of the other organs, and by the absence of nodules on the surface. Neither jaundice nor signs of portal obstruction are present. Cases have been reported by Reitman, Debove, and others in which the diagnosis of gastric ulcer was made during life, but cirrhosis of the liver was found on post-mortem examination.

PROGNOSIS.—The prognosis is absolutely unfavorable. It is extremely doubtful if a well-marked case of alcoholic cirrhosis has ever recovered. In some cases, after two or three tappings, the collateral circulation will become so well established that the patient may enjoy fair health for two or three years. In an occasional case the disease may come on in an acute form, with rapid evolution of ascites and hemorrhage, when with rest and careful treatment the symptoms will gradually disappear and the patient remain in fair health for some years. The writer had under observation a case of the kind in which the improvement was marked and continued for a year and a half, so that the patient was able to attend to his ordinary work. This condition of health might have continued much longer had he not returned to his habits of indulgence in alcohol. Fitz states that a fatal result may be expected within a year after the occurrence of gastric catarrh, hemorrhage, and the other signs of portal obstruction.

TREATMENT.—The first and most important indication is the avoidance of all those articles of food and drink which are known to irritate the hepatic parenchyma. Alcoholic beverages, and especially spirits, should be absolutely interdicted. Highly seasoned food, spices, and coffee should be forbidden. The diet should consist of milk, broths, a moderate amount of farinaceous food, vegetables with the exception of potatoes, and cooked fruit. It may be difficult to find articles of diet which the patient will take, on account of the anorexia and nausea.

At the onset of the disease, if the patient is plethoric, much good may be done by local bleeding or the use of wet cups, followed by warm applications over the hepatic region. The patient should at the same time remain in bed. In the later stages of the disease, when ascites is developed, appropriate treatment may prolong life, but will not effect a cure.

An attempt should be made to relieve the symptoms of gastro-intestinal catarrh. Carlsbad salts have been recommended, and Frerichs gave choleate of soda. Preparations containing bismuth and pepsin are often useful.

Medicinal remedies for the ascites are only occasionally followed by permanent success. One of the best diuretics is digitalis, which acts by increasing the blood pressure in the kidneys. This may be given with acetate of potash. Balsam of copaiba has been recommended by Garrod and Wilkes in from ten to twenty grain doses, three times daily. The ethereal oil of turpentine in doses of twelve drops twice daily has been mentioned by Thierfelder. Hydragogue cathartics have a decided effect in lessening the ascites in some cases. Compound jalap powder, gamboge, and elaterium have been given. The latter remedy I have found useful in some cases. When a good article can be procured its action is so effective that it need not be repeated as often as other cathartics, and on that account it does not produce so much weakening. The objection to the use of all these remedies is that the patient may lose strength thereby and the gastro-intestinal catarrh may be increased.

Sooner or later, in most cases, the question of the propriety of tapping the abdomen will arise. Some of the older writers were of the opinion that this operation should be postponed until symptoms of dis-

tress renders it necessary, because frequent tapping will lead to exhaustion of the patient. An early operation favors the removal of pressure and the easier establishment of anastomosis. Pressure is also removed from the surrounding organs, and their functions are therefore better performed. The patient will be able to breathe more freely and the urine is often increased in quantity. Diuretics, and in the writer's experience especially digitalis, act more effectually after tapping than before. Murchison was among the first to advocate this treatment, and it is now well established. If the ascites does not disappear after the use of eliminatives for some days, paracentesis should be resorted to. Care should be taken to avoid the introduction of germs, as well as to guard the patient against syncope from the sudden withdrawal of fluid.

Intestinal antiseptics are often indicated for the accumulation of gas in the bowels. Among the best are salol, bismuth salicylate, naphthol, and creasote.

Hemorrhage from the stomach and bowels is sometimes an alarming and even a fatal symptom. The patient should be kept absolutely quiet in bed with the head lowered. Ice should be applied over the stomach and bowels, and small pieces may be taken internally. Morphine should be administered to quiet the peristaltic action of the intestine. It may be given with bismuth. Ergot may be of service, and ergotine should be given hypodermically in urgent cases.

The use of tonics is indicated in almost every stage of the disease. The patient should spend as much time as possible in the open air and should take moderate exercise.

The *operation of paracentesis abdominis* is so often done that the physician is tempted to overlook details which may be of importance. The patient should be placed in a comfortable semi-recumbent posture, and the abdomen should be carefully examined to see that the dulness in the median line between the pubes and umbilicus is absolute. It is possible that intestines may be adherent to the anterior wall—a condition which could be made out by percussion. The urine should be drawn off by a catheter, so that there is no possibility of puncturing a distended bladder. The surface of the abdomen should then be washed with soap and water, and the lower part should be disinfected by a 5 per cent. solution of carbolic acid or by ether. The surface of the part to be punctured may then be frozen by ethyl chloride, and an incision made through the skin. The trocar and cannula should then be passed through. The puncture should be made in the median line halfway between the pubis and umbilicus. It is necessary to see that the patient is sitting straight in the bed, otherwise a mistake may be made as to the position of the median line.

The fluid should not be withdrawn too rapidly, to avoid rupture from distended peritoneal vessels and syncope from cerebral anæmia. When a rubber tube is attached to the trocar the fluid is more easily conveyed to a vessel on the floor. Stimulants may be given if there is any cardiac weakness. When the cannula is removed the opening may be covered by rubber plaster and a bandage applied.

Pressure may be made on the walls of the abdomen by a bandage which can be gradually tightened as the fluid is withdrawn.

Venous Hypertrophic Cirrhosis.

Hanot and Gilbert have described a venous hypertrophic cirrhosis distinct from the atrophic form and from the fatty hypertrophic or biliary hypertrophic variety.

In this disease increase of connective tissue which has been described as existing in the early stage of the ordinary alcoholic cirrhosis exists throughout the whole disease.

The SYMPTOMS are quite similar to those just given, with the exception that the liver remains enlarged instead of becoming atrophied.

Letulle[1] has reported a case of hypertrophic alcoholic cirrhosis in which pigment was found in the connective tissue, in Kupfer's cells, as well as in the hepatic cells.

True and false canaliculi and nodular hyperplasias were also observed. The pigment, which contains iron, was found in many other parts of the body.

Biliary Cirrhosis.

In this form of cirrhosis the lesions exist around the smaller biliary radicles, the circulation of blood remaining in the normal condition.

Chauffard has described two forms: 1. The hypertrophic cirrhosis of Hanot, and 2. Calculous cirrhosis.

1. Hypertrophic Biliary Cirrhosis with Chronic Jaundice.

According to Charcot, this form differs from the atrophic variety in two important particulars: (*a*) increase in volume, and (*b*) by the existence of certain lesions of the biliary canaliculi peculiar to this condition. There are other important clinical differences—for instance, the presence of more or less permanent jaundice, the absence of ascites, and the longer duration of the disease.

ETIOLOGY.—Hypertrophic cirrhosis occurs, as a rule, in young adults of the male sex. In Schachman's collection of 26 cases, 22 were males and 4 females. It usually occurs between the ages of twenty-two and thirty-five, and has rarely been found after forty.

Hanot, after enumerating the causes of hypertrophic cirrhosis which have been given by various authorities, arrives at the conclusion that alcohol and malaria are the only agents which have really been known to produce it. It must here be mentioned that Laveran, who has had an enormous experience in malarial fever, states that he has not seen this form of cirrhosis. The importance of alcohol as an etiological factor has not been properly estimated. Cases of this disease have occurred which were not produced either by alcohol or malaria. Jaccoud has reported one of this kind. The predisposition may develop in infancy or it may be hereditary. D'Espine has reported a remarkable case in an infant which died on the twenty-fifth day. Microscopical examination revealed a cirrhosis with inflammation of the smaller biliary ducts. No micro-organisms were found either in the viscera or in the blood, and there was no evidence of syphilis or history of that disease in the parents. The father was, however, an invete-

[1] *Bull. de la Société Anat. de Paris*, Dec., 1896.

rate drunkard. Joseph Eichberg of Cincinnati has recently reported (April, 1896) a case of hypertrophic biliary cirrhosis in a young woman twenty years of age in whom there was no history of alcoholism.

The occurrence of the disease after acute infectious fevers has given rise to the theory that a toxin may remain in the blood which may produce this condition in one predisposed to it. The fact that it occurs in domestic animals in connection with parasites indicates the possibility of the discovery of a special parasite at some future time.

Pathological Anatomy.—The liver is always enlarged, often weighing 2000 to 3000 grammes. It is not much changed in form. The anterior margin is sharp and the upper surface firm and generally smooth. It is usually covered with inflammatory membranes, and sometimes small nodular elevations of variable color are present. The organ is of firm consistence and cannot be easily penetrated by the finger. When cut with the knife some force is required and a gritty feeling sometimes is noticed. The cut surface presents a more or less uniformly green color. Grayish bands of connective tissue contain within their alveoli yellow or greenish lobules. There is usually no evidence of amyloid infiltration. The lymphatic glands in the portal fissure are not enlarged, and there is consequently no pressure on the vessels or ducts. The gall bladder is usually filled with bile, and does not present any special lesions. No obstruction is found in the larger passages.

Under a low-power lens a section of the liver presents broad fibrous bands with interspaces filled with parenchymatous tissue, which is of a reddish yellow or green color. The lobules are also separated by lesser bands (cirrhosis monolobularis). The connective tissue penetrates the lobules, changing their form and causing destruction of the hepatic cells. It almost always surrounds the biliary canals in the form of fibrous rings and exhibits a rich cellular development. The communication between the portal vein and the hepatic capillaries remains free, and the condition of the portal vein is not changed. The prolongations of connective tissue do not usually penetrate the lobule as far as the centre, but may cut off a portion from its central vein and give rise to what appear to be lobules without an interlobular vein.

The connective tissue does not contract and become cicatricial as in atrophic cirrhosis, but remains thick as in elephantiasis, giving rise to the term elephantiasis of the liver. The gall ducts are distended and filled with bile. They are lined with cubical cells, which, when enlarged, obstruct the flow of bile. Cholangitis and pericholangitis are always to some extent present. The number of intralobular bile ducts is greatly increased, especially just within the periphery. This increase of these channels was thought to be apparent rather than real, owing to the disappearance of hepatic cells, but they are now known to be of new formation. The presence of so many biliary canals in the fibrous tissue already referred to is one of the most prominent features of the disease. Notwithstanding the great increase of connective tissue, the hepatic cells, except those in the immediate neighborhood of the fibrous bands, undergo very little change. They retain their polyhedral form and the nucleus remains normal.

The pathological changes in the liver may be stated briefly as follows: (1) A diffuse and abundant increase of connective tissue, which

does not exhibit any marked tendency to contraction, and which contains many round cells and bile ducts of new formation. (2) Little change in the hepatic cells except close to the fibrous tissue. (3) A cholangitis and pericholangitis, which are constantly found in the smaller and medium biliary canals. The spleen is hypertrophied, sometimes to an extent as great as the liver, and may exhibit a perisplenitis on its surface. The kidneys are stained with bile, but do not show any other changes. The gastro-intestinal tract is usually normal, and the intestines do not present the retraction and atrophy sometimes found in atrophic cirrhosis.

PATHOLOGY.—An inflammation begins in some of the hepatic cells and extends along and around the smaller bile ducts, but the first apparent lesion is an inflammation of connective tissue around the latter. The agent causing the irritation is not known. It may be alcohol or a toxin which remains in the blood after some infectious disease. It is probable that a congenital predisposition exists in some cases. A form of parasitic biliary cirrhosis is found in animals, but similar cases have not been discovered in man.

CLINICAL HISTORY.—A brief description of the disease, as given by Hanot, is as follows: A young man between twenty and thirty years of age becomes gradually jaundiced, while at the same time he suffers from exacerbations of pain felt in the right hypochondrium. The pain is usually of a dull character and is increased on pressure. In the exacerbations it resembles that of hepatic colic, but is never so severe. To these symptoms are added a little fever, loss of appetite, and some loss of strength. The pain may cease for a time, and after an interval of comparative comfort it returns and the jaundice increases in intensity. The exacerbations are always accompanied by general malaise. The jaundice persists throughout the interval and is increased at each exacerbation. These attacks, followed by intervals, may occur again and again for months, when the abdomen becomes distended. This increase in size is not due to ascites, but to an enlarged liver, which occupies not only the whole of the right hypochondrium, but may extend across the epigastrium and fill the right flank as well as the right iliac fossa. The surface is smooth, firm, and more or less tenderness is felt on pressure. Except during the exacerbations the general health may remain fairly good for the first six or eight months. The jaundice becomes intense, but the cachexia may not follow until some months later. A gradual loss of strength is then noticed, while the liver may become somewhat diminished in size. As the failure of nutrition continues petechiæ present themselves on the skin, the general hue of the integument becomes greenish, and the emaciation may be extreme. Ascites is absent or may exist in a very slight degree, and the subcutaneous abdominal veins are not enlarged. The spleen is often enlarged. Hemorrhage from the stomach and intestine may supervene and the patient passes into a comatose state.

The DURATION of the disease varies as the exacerbations occur at longer or shorter intervals, but the general course is much the same in all cases.

It is often noticed that at the commencement the pain and jaundice occur together, and that the patient had previously enjoyed good health.

The attacks appear without cause, and are often accompanied by symptoms of acute dyspepsia. They sometimes come on after errors in diet, especially after eating acid fruits. In an exceptional case mentioned by Jaccoud the jaundice did not come on until five months after the onset of pain in the hypochondrium. In some case the enlargement of the abdomen is the first sign noticed by the patient, although he may have for months suffered from slight jaundice. The pain varies in severity, and is partly produced by the perihepatitis which is frequently found on post-mortem examination. The earlier exacerbations are marked by slight elevations of temperature and increased rapidity of the pulse.

The fever does not last long, nor does it always accompany subsequent exacerbations.

Jaundice is one of the most prominent manifestations of the disease. It may be slight at first and increase gradually, or it may be very marked from the beginning. In some cases the jaundice increases rapidly in intensity, and the patient may die in a condition similar to that of acute yellow atrophy. The skin is usually dry, and often presents a lichenoid eruption without pruritus. The urine is high colored and contains biliverdin. The excretion of urea is normal. Notwithstanding the presence of jaundice the fecal discharges are colored in the majority of cases. In 26 cases investigated by Hanot discoloration was noticed only in 2. Cornil found in 2 cases a large amount of bile in the intestine.

Symptoms in Detail.—Enlargement of the liver is a necessary condition of the fully developed disease. It is difficult to say when this commences, as it is generally marked when the patient consults a physician or first enters the hospital. It is probable that the hypertrophy begins when the first attacks of pain and jaundice occur, but that it is not recognized until some time afterward. The surface of the liver is hard and resistant on palpation. It is smooth and the anterior margin can be distinctly felt. When perihepatitis is present the surface may be roughened, and what appear to be nodules may be felt. The hypertrophy is permanent and lasts as long as the disease. In some exceptional cases there is a slight diminution of volume during the last few months. More or less enlargement of the spleen is present in a majority of cases. Hanot found it much enlarged in 10 out of 26 cases.

The absence of ascites is one of the peculiarities of this form of cirrhosis. In the later stages a moderate amount of fluid may be found in the peritoneal cavity, but ascites is never present at the commencement or when the disease is established, as in atrophic cirrhosis. Fluid in the abdomen is the result in most cases of peritonitis, and is not due to portal obstruction. A perihepatic inflammation is sometimes the cause of hydro-peritoneum and œdema of the lower extremities. In a few cases in the most advanced stages the inflammation may extend so as to produce a slight pressure on the portal veins and thus cause ascites. It was altogether absent in 19 of Hanot's cases.

The enlargement of the subcutaneous abdominal veins, so common in atrophic cirrhosis, is wanting in the hypertrophic form, except in the last stages of the disease.

The digestive disturbances have been already referred to. They are not unlike those of catarrhal jaundice. A peculiar feature is that

the patient enjoys a fair appetite throughout the greater part of the disease, notwithstanding the presence of jaundice and enlargement of the liver and spleen. When one remembers how constantly anorexia is found in diseases of the liver, the possession of a good appetite is a peculiar and striking symptom. A true bulimia has been noted. One patient was obliged to get up twice during the night to eat.

Alternating constipation and diarrhœa are frequent symptoms.

According to Hanot, the quantity of urine daily eliminated may vary from 1300 to 1500, and the quantity of urea from 11 to 24, grammes. The quantity of uric acid remains normal. The diminution of urea is not explained by a less amount of food, as Hanot observed considerable diminution in a patient who had a normal appetite. The quantity of urea may be increased during an exacerbation or near the termination of the disease. Both sugar and albumin are absent and the toxicity of the urine is lessened.

Hanot sums up the principal phenomena connected with metabolism in hypertrophic cirrhosis as follows: Slight diminution of the urea, feeble toxicity of the urine, slight loss of weight, preservation of the appetite, and a relative preservation of the vital force.

Course and Duration.—Hypertrophic cirrhosis is a chronic condition which usually lasts more than two years and may last eight or ten years.

Diagnosis.—The disease is to be differentiated from alcoholic cirrhosis, from syphilitic, pigmentary, and tubercular diseases of the liver, and cirrhosis from obstruction of the bile ducts. In their typical forms it is easy to distinguish between atrophic and the hypertrophic cirrhosis of Hanot. In the former diminished dulness in the hepatic region, ascites, and intestinal hemorrhages are very constant symptoms. The prominence of the subcutaneous veins, the mild nature of the jaundice, and the occurrence of the disease in middle life are also important distinguishing characteristics. In the hypertrophic form the hepatic dulness is increased, ascites is usually absent, the subcutaneous abdominal veins are not prominent, intense jaundice is a constant symptom, and the disease attacks young adults about twenty-five years of age. In the early stage of alcoholic cirrhosis there is sometimes a considerable enlargement of the liver, and a previously existing fatty liver may become cirrhosed. These conditions are diagnosed from the hypertrophic cirrhosis of Hanot with greater difficulty. The fact that some authors do not discriminate between the biliary cirrhosis with chronic jaundice and the hypertrophic form of perivascular cirrhosis has led to much confusion. The peculiar exacerbation of pain and jaundice which characterizes the former is not present in fatty cirrhosis. Hanot gives the following prominent characteristics of the latter disease, which distinguish it from the condition now under consideration: (1) An undoubted history of alcoholism; (2) the presence of corpulence and of the digestive troubles of alcoholism; (3) the amount of hypertrophy is not great; (4) jaundice does not appear until after the commencement of the second stage.

Some exceptional cases of atrophic cirrhosis are accompanied by very severe jaundice even in the first stage, and may then resemble the biliary form. The lessened hepatic dulness and the presence of ascitic fluid will render the differentiation less difficult. Occasionally a case of mixed

disease is observed in which the enlargement of biliary cirrhosis exists, together with some of the signs of the atrophic form, as ascites, prominence of the abdominal veins, etc.

A syphilitic liver may be the seat of pain accompanied by jaundice. In the majority of cases the latter symptom is either absent or of slight intensity, except in those of biliary obstruction due to pressure on the larger ducts in the portal fissure. Ascites may then be a complication also. The syphilitic liver presents anomalies of form, and nodular elevations are felt on the surface. The history of syphilis and its manifestations in other parts of the body will aid in the differentiation.

Gall Stones and Biliary Colic.—In the exacerbations of this disease the pain is much more severe, and the jaundice, although intense at first, will often disappear in the intervals. If the area of hepatic dulness is increased on account of perihepatic inflammation, the local tenderness will be more marked than in hypertrophic cirrhosis. When there is partial stenosis or occlusion due to gall stones or other causes, the gall ducts will become dilated and a condition of the liver produced which may clinically resemble biliary cirrhosis. This will be considered farther on (page 566).

In abscess of the liver the course of the disease is shorter, not extending over more than from three to five months, the pain is more intense, the tenderness is greater, and the febrile symptoms are much more marked. The physical signs of abscess are present. Jaundice is less intense and of much shorter duration in the latter disease.

Primary Cancer of the Liver, Gall Bladder, and Biliary Passages.—The rapid enlargement, the presence of nodules, the manifestations of secondary deposits in other organs, the shorter duration of the disease, the absence of jaundice in many cases, and the presence of cachexia and emaciation will serve to differentiate this disease from hypertrophic cirrhosis. Cancer occurs about or after middle life and hypertrophic cirrhosis in early adult life. When the cancerous tumor causes obstruction of the common bile duct, jaundice may come on more rapidly than in biliary cirrhosis, and the tumor can probably be felt on palpation.

Prolonged catarrhal jaundice is differentiated by the absence of decided enlargement of the liver and spleen.

Cardiac liver with jaundice may be recognized by the history and by the presence of the cardiac lesions. The diminution of the hypertrophy with rest and treatment is an important characteristic of cardiac liver.

Amyloid liver will present similar physical signs on palpation and percussion, but is distinguished by the absence of jaundice.

The presence of multilocular echinococcus cysts of the liver is differentiated by the presence of tumors on the surface and of greater tenderness, as well as by the absence of jaundice.

Prognosis.—So far as known, the disease always terminates fatally, although in some cases the patient may enjoy many years of fairly good health. The integrity of the hepatic cell, which is a striking feature of the disease, accounts for its chronicity. When, however, appropriate treatment is adopted early, a cure would not seem impossible. In the cases reported the patients have not come under the physician's care until the disease had been thoroughly established.

TREATMENT.—Abstinence from alcohol must first be enjoined in the treatment of Hanot's cirrhosis. At the same time, all irritating articles of food or such as contain toxins should be avoided. Constipation should be relieved by mild saline laxatives. Intestinal decomposition should as much as possible be counteracted by calomel, naphthol, and salol. Diuretics to aid in the elimination of poisons are also indicated. Milk, which is an excellent article of diet, will increase the action of the kidneys.

2. Calculous Cirrhosis.

This term has been used to designate a form of cirrhosis which results from obstructive jaundice. In addition to the changes already described under the head of Jaundice, as well as destruction of the liver cells, there is an increase of connective tissue which surrounds the smaller ducts. The fibres are very firm and contain but few nuclei. That portion of the connective tissue away from the ducts is of a cicatricial character, as in ordinary cirrhosis. The capsule is thickened and presents a firm fibrous structure. The dilated ducts may contain bile or mucin stained with biliverdin. The formation of connective tissue has been demonstrated in animals after tying the common bile duct. Frerichs, Charcot, and Sabourin have thus demonstrated the dilatation of the biliary ducts, the presence of cholangitis and pericholangitis, increase of the connective tissue, and destruction of the hepatic cells. Kelsch has observed cases of cirrhosis resulting from retention of bile.[1]

The principal difference between the calculous and hypertrophic cirrhosis of Hanot is that in the former the hepatic cell is early affected, whereas in the latter it remains healthy, notwithstanding the great increase of connective tissue. The clinical differences have already been referred to.

PIGMENTARY LIVER.

The following forms of pigmentary cirrhosis have been described:

(1) That due to the poisoning of malaria;
(2) A form sometimes found in diabetes;
(3) Anthracosis of the liver.

In a number of cases pigmentation takes place, which may or may not be accompanied by cirrhosis, as in passive congestion, in the liver of old age, in Bright's disease, in certain forms of carcinoma, and in pernicious anæmia. In such cases the pigment is usually deposited around the sublobular veins. In pernicious anæmia the iron is found in the middle and outer zones of the lobules.

(1) Malarial Form.

Frerichs expressed the opinion that pigmentary matter was formed in the spleen and then conveyed and deposited in the liver. Afterward Kelsch demonstrated that the red corpuscles were destroyed by the malarial poison, and that the pigment was deposited principally in the liver, but was also found in other parts of the body—the spleen, intestine, and central nervous system. Much progress has been made in the study of malaria, and especially of the changes which take place in the

[1] *Revue de Médicine*, 1881, p. 969.

blood-corpuscles, since the discovery of the plasmodium malariæ of Laveran.

Morbid Anatomy.—The liver presents different conditions, depending on the duration of the disease and whether it is of an acute or subacute character. In those who die from acute malarial poisoning the organ may not be much enlarged, but it is congested and of a dusky brown color. It is also more or less friable, and in some cases is saturated with bile; the gall bladder is distended, and the intestines also contain large quantities of the biliary secretion.

On microscopical examination the intralobular capillaries are found filled with leucocytes containing pigment and malarial organisms, forming in places pigmentary thrombi. The endothelial cells in the walls of the capillaries contain pigment, but the hepatic cells and connective tissue are free from it. Kelsch and Kiener have described in addition a yellow pigment which exists in hepatic cells, insoluble in water and alcohol, and resists the action of acids and potash. This is found widely distributed in malaria, but is not peculiar to it. It differs from hæmatin and hæmatoidin in the fact that it is a direct product of cell action and not a transudation. In addition to these changes, evidence of inflammatory action is shown by the proliferation of cells on the surface of the capillary walls, the enlarged nuclei of the hepatic cells, and the round-celled infiltration in parts of Glisson's capsule. In a case of acute æstivo-autumnal malaria recently described by Barker in the *Johns Hopkins Hospital Reports* the liver, in addition to the changes already described, presented areas of necrosis varying in size, in which the hepatic cells had undergone greater or less destruction. In chronic malaria the liver may be much enlarged, and has a brown, grayish brown, or slate color. It is often dark from congestion, and the capsule is more or less tense. The connective tissue is increased and the cirrhosis is more marked if the disease has been of long duration. The glandular structure may be destroyed and the liver become small and hard.

Some pathologists have doubted the possibility of cirrhosis resulting from the malarial poisoning alone. In most of the cases described the possibility of alcohol as a cause was not altogether eliminated, and on this continent very few cases have been reported. Barker of Johns Hopkins Hospital arrives at the conclusion after a careful study of his cases that the changes in the liver in malaria are similar to those which end in cirrhosis, and he is convinced that paludal poison might under some circumstances produce a cirrhotic condition. The greater number of cases of pigmentary cirrhosis described by writers in tropical countries may be due to a greater intensity of the poisoning or to differences of resistance in the individual.

Microscopical Examination.—The connective tissue between the hepatic cells is increased in amount and the cells are swollen, and the nuclei much enlarged and in process of division. The cells afterward undergo degeneration, and pigment is sometimes found near the periphery of the lobule. Glisson's capsule presents more or less thickening and is rich in round cells, and masses of pigment varying in size are disseminated through it. Malarial pigment is found within the capillaries, in the red corpuscles, in the leucocytes, and in large phago-

cytes which probably originate in the spleen. It is also found in the endothelial cells and outside of the capillaries, in the cells of Küpfer, in the connective tissue, and in some hepatic cells near the periphery of the lobules. Kelsch and Kiener give a résumé of the inflammatory changes produced by malaria in the liver as follows:

(1) Accumulation of iron pigment in the hepatic cells;
(2) The nutrition of the hepatic cells is affected;
(3) Biliary stasis;
(4) Diapedesis the result of inflammation;
(5) Cirrhosis.

The same authors have described the different types of the disease depending upon the evolution of the malarial poisoning. In one of these, an ischæmic atrophy, the hepatic cells surcharged with pigment undergo necrobiosis. A nodular form of parenchymatous hepatitis has also been described.

Clinical History.—In the acute form of malaria as it occurs in tropical climates the involvement of the liver is known by digestive disturbances, the vomiting of matter stained with bile, bilious diarrhœa, swelling and tenderness of the liver, and highly colored urine which does not often contain bile pigment. In temperate climates marked symptoms are not likely to occur, but distinct enlargement and tenderness of the liver have been noticed by the writer in malarial cases, symptoms which disappeared after the administration of quinine. In the chronic form the liver may be enlarged and firm and the area of hepatic dulness increased. When the process is of longer duration, according to French authorities, owing to the cirrhotic changes the liver may be lessened in volume and the hepatic dulness diminished. It is quite probable that alcohol may have had an important influence in the development of cirrhosis. The skin in such cases presents a subicteric tint and the coloring matter of the bile may be found in the urine. The latter is, however, not at all constant. Profuse diarrhœa and the presence of a moderate amount of fluid in the peritoneal cavity may be caused by obstruction of the portal circulation from pigmentary thrombi in the small portal veins. Frerichs has reported some acute cases in which intestinal hemorrhages of a distinctly intermittent character were cured by the internal administration of quinine. This may have resulted from the direct action of the malarial poison on the mucous membrane of the intestine, producing thrombi, ulceration, etc. The same author described four classes of cases which he found in connection with pigmentary liver:

(1) Cases with predominant liver symptoms;
(2) Those in which the kidneys are principally affected;
(3) Cases with derangements of the gastro-intestinal tract;
(4) A class in which anasarca and enlargement of the spleen were the prominent features.

The symptoms in these several classes of cases are now more easily explained, as we know that in different individuals the malarial germ seems to act especially on certain organs. In the majority the liver is especially involved, whereas in some the intestines or nervous system is the principal seat of change.

Diagnosis.—It is necessary, first, to establish the fact of the pres-

ence of malaria. This can be done readily by an examination of the blood. The condition of the liver may then be suspected if the symptoms peculiar to liver disturbance be present—bilious vomiting, bilious diarrhœa, and enlargement and tenderness of the organ. The curative action of large doses of quinine will aid the physician in arriving at a correct conclusion when he has not at hand the facilities for making a blood examination.

Treatment.—In the acute cases the treatment for the constitutional condition is of the most importance. Local depletion has been recommended in addition to the free administration of quinine. In the chronic form the patient should, if possible, be removed to a district free from malaria. Rhubarb and salines may be given to relieve the congestion, although, as a rule, this disappears with the cure of the malaria. For the hepatic enlargement which often follows malaria the remedies which have been found of service are quinine and nitro-muriatic acid. Some older writers recommend the local application of mercurial ointment.

The diet should be limited to articles which are unstimulating and easily digested, such as milk, a moderate amount of farinaceous food, soups, and a small allowance of meat. Sweets, pastry, and highly seasoned food should be avoided.

(2) Diabetic Form.

A form of pigmentary cirrhosis in connection with diabetes has been described by French writers. Trousseau related an instance in his clinical medicine, and Hirsch and Chauffard have published cases. The literature on this subject has been nearly all of French origin. Saunby described a case of pigmentary cirrhosis with diabetes in the *British Medical Journal*, 1890. This condition occurs in diabetic patients who have a bronzed skin resembling that of Addison's disease. The three conditions exist together—hypertrophic cirrhosis, pigmentary deposit, and saccharine diabetes. The liver is moderately enlarged, weighing from 1700 to 3200 grammes, and the right lobe is principally affected. It is of firm consistence and of a brownish red color, with dark spots under the capsule. The cut surface is firm, the gall ducts permeable, and the bile normal in appearance. The hepatic cells contain pigment of a yellowish brown or black color accumulated around the nuclei, with more or less necrobiosis. Each cell becomes atrophied in proportion to the amount of pigment. The connective tissue is increased not only around, but within, the lobules. A portion of a lobule may be separated from the remainder in this way. The fibrous structure is invaded with pigment which originates in the hepatic cells, and when these latter are destroyed by pressure the pigment alone remains.

The condition of the other organs seems to vary. The pancreas has in some cases been found hard and firm and of a reddish brown color. The kidneys are usually healthy, but sometimes pigment is found in the tubular epithelium.

Clinical History.—In addition to the ordinary symptoms of diabetes the increase in the size of the liver may be sufficient to cause increased hepatic dulness. Occasionally symptoms resulting from

portal obstruction, such as ascites and intestinal hemorrhage, are present.

PATHOLOGY.—A difference of opinion exists as to the origin of the pigment in such cases, whether it is formed in the cell or deposited from the blood. Hanot and Chauffard are of opinion that the liver is the seat of formation of pigment, whereas Letulle finds it difficult to admit that pigment the result of exaggerated chromogenesis would cause atrophy and death of the cells.

No special TREATMENT has been suggested.

(3) Anthracosis of the Liver.

Subel has made experiments on frogs by injecting finely divided indigo into the abdominal veins. The particles of coloring matter were afterward found in the leucocytes of the circulating blood. These became rapidly less numerous, and they disappeared altogether after twenty-four hours. On killing the frog it was found that the portal capillaries were filled with particles of coloring matter, whereas those of the hepatic vein were comparatively free. The pigment not only existed within the capillaries, but also in the endothelial cells. It will thus be seen that the liver arrests pigment taken up from the portal system, and particles of coal dust may be in this way lodged in the organ.

Welch reports a case of cirrhosis hepatis anthracotica in the *Johns Hopkins Bulletin*, 1891. The patient, a man seventy years of age, had two years previous to his death begun to suffer from vomiting, loss of appetite, and severe pain in the abdomen. Fluid accumulated in the peritoneal cavity to such an extent that it was necessary to have it drawn off several times. At the time of his death the patient was very much emaciated. At the autopsy carcinomatous nodules were found in the peritoneum and liver, which were quite full of pigment which bore no relation to that of anthracosis. Particles of coal pigment were found in scattered areas, not uniformly distributed as in cases of malarial pigmentation. They did not undergo any change on application of strong sulphuric, glacial acetic, hydrochloric, or nitric acids, nor were they affected by strong ammonia and caustic potash. This form of cirrhosis is thus described by Welch: "The histological picture is quite different from that of ordinary hepatic cirrhosis. Instead of interlacing bands of connective tissue more or less completely surrounding lobules or groups of lobules, we have in the present instance sharply circumscribed round, oval, and elongated discrete areas of sclerotic at times nearly homogeneous fibrous tissue, containing such masses of coal pigment as to appear in places almost uniformly black."

Weigert has shown that coal dust which is taken in by the lungs, and which is usually arrested by the bronchial lymphatic glands, may, when there is much destructive inflammation, pass into the general circulation and be lodged in the spleen, liver, and other organs. A similar condition may allow pigment to pass from the lungs into the blood. The frequent association between emphysema of the lungs and pigmentary deposit has been pointed out by Arnold. Although cases of deposit of small particles of coal dust in the liver have been described by several observers, Welch's case was the first instance of a general cirrhosis, and

the name cirrhosis hepatis anthracotica was first used by him. The atrophy and death of liver cells seem to be the primary change leading to cirrhosis, and this may be produced either mechanically or chemically. Welch considers the former the more probable view.

TUBERCULOSIS OF THE LIVER.[1]

CERTAIN changes are very constantly observed in the liver in advanced cases of pulmonary tuberculosis—for instance, fatty infiltration and degeneration, the result of insufficient oxidation of the blood, amyloid degeneration, which occurs not infrequently, and passive congestion due to obstruction in the pulmonary circulation. Those conditions only which are directly produced by the bacillus or its toxin will be considered here.

The older authors, Murchison, Frerichs, and Lebert, were of the opinion that tuberculosis of the liver was a rare condition, This arose partly from the fact that the tubercles are often so small that they cannot be recognized with the naked eye. Since more careful microscopical examinations have been made, it has been shown that tuberculosis is rarely absent when the disease in other parts of the body is the cause of death. The involvement of the liver to a greater or less degree is the rule, no matter in which organ the original disease is found. It occurs less often in old people, and is most frequent in cases of abdominal tuberculosis.

The morbific agent may enter the liver through the hepatic artery, the portal vein, the lymphatics, and the biliary passages. It has been demonstrated by experiments on animals that the bacilli of tuberculosis can be introduced through these various channels, but it has not been proven that these micro-organisms enter in the same way in man.

When the bacilli enter through the bloodvessels, they are arrested in the capillaries and set up an inflammatory action which results in the formation of epithelioid and giant cells. The hepatic cells, according to Gilbert, do not take any part in the formation of tubercle.

It is sometimes difficult to distinguish tubercle from lymphoid growths. As stated by Chauffard, the bacillus of tuberculosis, besides setting up this specific form of inflammation, may cause fatty infiltration and the various forms of cell degeneration and sclerosis. Hanot and Gilbert have demonstrated by experiments on rabbits that a true cirrhosis of the liver may be produced by the introduction of tuberculous matter. In these experiments they discovered that human tubercle was very virulent to rabbits, producing marked changes in the liver and a moderate tendency to the evolution of sclerosis. On the other hand, they found that the tubercular poison from birds was less virulent to rabbits, and produced changes in the liver which resulted in marked cirrhosis. From these experiments they conclude that in the human subject the development of tubercular cirrhosis of the liver is due either to abnormal individual resistance to this particular infection or to the introduction of a less virulent poison.

In the study of this subject one fact has already been established—viz. that the liver is affected in varying intensity in different indi-

[1] See also Vol. I. pp. 816, 817.

viduals, and that this does not bear any relation to the condition of the other organs. For instance, a slight involvement of the liver may take place when the lungs have been to a great extent destroyed, and *vice versâ*.

The frequency of tuberculosis of the liver has been shown by Simmonds to be greater than that of the lungs. In 100 tubercular individuals the liver was affected in 82 per cent. (76 per cent. in adults and 92 per cent. in children). Tuberculosis of the lungs was found in 76 per cent.

The liver does not seem to be a favorable soil for the further development of tubercles, as the nodules are nearly always small, and, as a rule, there is not much destruction of parenchyma.

Tubercle of the liver exists in several different forms:

(1) The miliary tubercle;
(2) Tubercle of the smaller bile ducts;
(3) Large caseous masses;
(4) Tubercular cirrhosis.

(1) The miliary tubercles which are found when there is a general invasion of the system are small and may be accompanied by more or less fatty degeneration of the liver cells. They are usually situated near the periphery of the hepatic lobules or in the connective tissue immediately around the hepatic vein. According to Buissaud, the degeneration which exists in the centre of the nodules is more frequent in the tuberculosis of children. When sufficient time is given for their development the masses can be easily seen with the naked eye; the smaller ones are single tubercles, while the larger are composed of aggregations of tubercles. The caseation which takes place does not usually go on to necrosis or the formation of cavities.

(2) In the second form, that in which small tubercles surround the biliary radicles, cavities are sometimes formed which communicate with the bile ducts. The contents of the cavity are in this case tinged with bile. They are usually not larger than a pea or a cherry. The bile duct itself may be affected and a tuberculous cholangitis result. This is occasionally combined with a catarrhal inflammation. In some cases no doubt other organisms than the tubercle bacilli may be active agents in the formation of cavities and in producing the subsequent cholangitis. The process which takes place is not unlike that of the formation of cavities in the lungs. The origin of this second form of tuberculosis seems to be different from that of the first variety. Klebs and Orth are of the opinion that the bacilli find their way through the lymphatic ducts. This seems to be confirmed by the fact that they are first found in the outer portion of the wall, and subsequently in the lining membrane of the bile ducts. Some authorities, however, are of opinion that in this form of tuberculosis the micro-organism finds its way into the liver through the excretory ducts.

(3) In the third form massive tubercles are found in the liver itself or in the perihepatic tissue. They may vary in size, sometimes reaching that of an orange. The liver is more or less fatty, and there may be an accompanying cirrhosis.

(4) Tubercular Cirrhosis.—This condition has been investigated by Hutinel[1] and Sabourin,[2] and has since been described by others.

[1] *Étude sur Quelques cas de Cirrhose avec Steatom du Foie*, 188.
[2] "Sur un Variété de Cirrhose hypertroph. du Foie," *Arch. de Physiolog.*, 1881, p. 584.

More or less interstitial hepatitis exists in many cases of miliary tubercle, and it may also be found with tubercular perihepatitis; but marked cirrhosis rarely exists in any form of tuberculosis unless it is produced by some other agent, as alcohol.

The following classification of tubercular hepatitis has been made by Hanot and Gilbert:

(*A*) Latent form.

(*B*) Acute form,
1. Fatty hypertrophy;
2. Cirrhosis.

(*C*) Subacute form,
1. Fatty tubercular hepatitis with atrophy or without hypertrophy;
2. Parenchymatous nodular tubercular hepatitis.

(*D*) Chronic form,
1. Tubercular cirrhosis;
2. Fatty degeneration.

Two forms of tubercular cirrhosis have been distinguished pathologically—the fatty hypertrophic form, and that in which there is atrophy or the organ maintains its normal size.

In the first the hypertrophy is regular and the several lobes are equally affected. A dry perihepatic inflammation exists, with adhesions binding the liver to the under surface of the diaphragm. The cut surface has a yellow color and is more or less fatty. The specific gravity is not much diminished—not nearly as much as in ordinary fatty liver.

Upon microscopical examination the results of a subacute inflammation are found in the interlobular spaces. The connective tissue is increased around the bloodvessels and the bile ducts, and islets of sclerosis are found in places. The connective-tissue bands differ from those of other forms of cirrhosis in the following particulars: (*a*) They are not so hard or fibrous, but rich in elastic fibres and round cells; (*b*) Isolated or conglomerate tubercles are found in the connective tissue or in the adjacent parts of lobules. These may have in their centre giant or epithelioid cells. (*c*) Sometimes the connective tissue invades the lobules and surrounds the cells, producing a monocellular cirrhosis. The hepatic cells undergo fatty degeneration and absorption. Those least affected are found midway between the centre and the periphery of the lobule. In alcoholic subjects some of the lesions mentioned may be due to the irritant effect of alcohol. Hanot, however, was of the opinion that tuberculosis alone might produce all the lesions described. Hanot's theory seems to have been proven by Hutinel, who found this variety present in 4 children six, seven and a half, eleven, and twelve years of age. The possibility of alcohol as an agent was positively excluded. Chauffard believes that tuberculosis is the principal cause in these cases, and that alcohol, biliary infection, and intestinal toxins are secondary and accidental agents. As to the method by which these lesions originate in tuberculosis, Hanot has expressed the opinion that they result from the toxin produced by Koch's bacillus. In tuberculosis of the liver Koch has observed punctiform spots of a reddish color which were found to be not extravasations, but enlarged capillaries which seemed to interrupt the circulation.

Symptoms.—In the miliary form, which occurs secondarily to disease elsewhere, the involvement of the liver may produce no special symptoms.

Very often when, in the course of pulmonary tuberculosis, the liver is attacked, the patient will become suddenly weak and will be obliged to remain in bed, when a state of asthenia becomes rapidly established. The urine is scanty and contains a small quantity of urea. Indican, leucin, and tyrosin may be present. A small amount of albumin is constantly found in the urine. Jaundice, which is present in a greater or less degree in some cases, is more pronounced when the common bile duct is obstructed by pressure from enlarged tubercular glands. The upper extremities become œdematous, and hemorrhages occur from the mucous membranes of the nose, the stomach, and the bowels.

With these occur the usual symptoms of the later stage of tuberculosis—restlessness, delirium, subsultus, and coma. Examination of the abdomen does not always reveal signs of hepatic disease. There may be distention with more or less ascites. The liver may be uniformly enlarged, and hepatic dulness may extend two or three inches below the costal margin. The surface may be smooth, and there is more or less tenderness on pressure. The spleen is often enlarged.

In hypertrophic tubercular cirrhosis the course may be somewhat similar to that of the alcoholic form; in fact, the two conditions often occur together. In the premonitory stage symptoms of chronic alcoholism, such as anorexia, morning vomiting, tremor, distention of the abdomen, enlargement and tenderness of the liver, scanty urine, and temporary glycosuria, may be present. These may be combined with symptoms of pulmonary tuberculosis, as cough, nummular sputum, night-sweats, emaciation, etc.

The examination of the abdomen does not always afford positive signs of hepatic tuberculosis. It is often more or less distended by gas in the intestine, and ascites is often present, but it is not sufficiently marked to render paracentesis necessary. The liver in the hypertrophic form is uniformly enlarged, and hepatic dulness may extend from a few lines to two inches below the costal margin. More or less tenderness is experienced over the surface.

Treatment.—The general treatment of tuberculosis is indicated, but cod-liver oil should not be given. It may be necessary to administer hydragogue cathartics and diuretics on account of the fluid in the peritoneal cavity.

SYPHILIS OF THE LIVER.[1]

The liver, of all the internal viscera, is the organ most frequently affected by syphilis. The effect of the poison on the hepatic cell in the secondary stage has already been described. The destruction of cells may be followed by a cirrhosis, and Murchison states that in the secondary stage syphilis may cause acute yellow atrophy, and quotes Lebert.[2] The changes met with in the liver occur almost always in the third stage of the disease. The following forms are met with:

(1) Simple interstitial hepatitis with perihepatitis;

[1] See also Vol. I. pp. 879, 880.

[2] *Virchow's Archiv*, 1854.

(2) Gummatous or sclero-gummatous hepatitis;
(3) Amyloid liver.

Certain differences are found in the liver at various ages. Following Chauffard, the pathological changes will be described as they occur (1) in the fœtus and newly-born child, and (2) in the hereditary and acquired syphilis of the adult.

(1) Syphilitic Liver in the Fœtus and Infant.

The fœtus in utero may be affected by the syphilitic poison through the mother, and the disease is found most frequently in cases which have not been treated. The syphilitic poison seems to affect particularly the liver, and to produce marked changes which will be described farther on.

One of the most important effects of syphilis of the fœtus is the presence of hydramnios, from which both mother and child may be seriously affected. Abortion takes place in about 25 per cent. of all cases of syphilis, and labor is more or less complicated in about one sixth of those who reach full term. The mother presents the usual symptoms and general signs of hydramnios. The abdomen may be enormously distended and the movements of the fœtus be slightly felt. The presence of such a large quantity of fluid produce symptoms of pressure, vomiting, cyanosis, and more or less abdominal pain. In the newly born the child may be so profoundly affected that death takes place immediately or a few days after birth. In other cases the patient may live three or four months with the usual manifestations of infantile syphilis—polymorphous eruption on the skin, mucous patches, coryza, emaciation, and bone deformities. The liver is always more or less affected, and symptoms depending on the hepatic condition are more or less marked. Jaundice does not often occur. Ascites is not common, and when it does take place the fluid is not abundant. Digestive troubles, vomiting, and diarrhœa are frequently present, increasing the marasmus. The liver is often enlarged to an intense degree, the lower margin being sometimes found on a line with the crest of the ilium. The child suffers more or less pain, as shown by screaming and drawing up the limbs in the effort to relax the abdomen. The surface is also tender, and the abdomen is distended by gas in the intestine and presents a globular form. The spleen is also enlarged, but not to such an extent as the liver. It is often felt as a large floating mass in the left side of the abdomen, and more or less tenderness is noticed over its surface. The child becomes gradually more and more exhausted, and death may be hastened by diarrhœa or peritonitis.

Pathological Anatomy.—The liver may in some instances appear healthy, but it is generally much modified. It is hypertrophied and presents a deep red color, and is much congested. It may be pale brown, and be in some places more or less transparent, the silex appearance of Gubler. The capsule is tense and thickened, the shape more or less globular, and the surface smooth. In some instances the evidences of perihepatitis are present, together with pericholangitis and pericholecystitis.

The cut surface presents a uniformly violet tint or the color is more or less variegated. Small disseminated nodules are found of a whitish

opaque appearance which cannot be enucleated—the miliary gummata of Virchow. These nodules may grow to a much larger size if the patient lives long enough, and may resemble the gummata of the adult form.

The diffuse syphilitic lesions commence by intense congestion of the capillaries, followed by stasis. This is due to a diapedesis of white blood-corpuscles which, together with proliferating connective-tissue cells, produce more or less induration. The cirrhosis commences around the portal vein and may extend up into the lobules themselves. The nodules at first are composed of embryonal cells. They increase in size by growth at the periphery or by the aggregation of neighboring nodules. They may exhibit more or less softening in the centre.

In those cases in which the syphilis has been cured the liver presents the signs of old interstitial inflammation. The case of a syphilitic child is reported by Chauffard in which death occurred at the age of eighteen months from broncho-pneumonia. The syphilitic condition had long passed away. On post-mortem examination the liver weighed 500 grammes and the spleen was also hypertrophied. The surface of the liver seemed normal, but the section exhibited evidences of an old interstitial inflammation. Although the nodules had almost altogether disappeared, there was a marked thickening of Glisson's capsule, especially around the portal vein. The walls of the latter were also thickened, but the vessels were permeable. The branches of the hepatic vein did not exhibit any change, and the cells in the lobules presented the normal arrangement.

(2) Syphilitic Liver in the Adult.

The liver has frequently been found presenting the evidences of old syphilitic inflammation when the patient did not exhibit any symptoms referable to that condition during life. The pressure on the bile ducts and bloodvessels is not so great as one might suppose from the changes which are found after death. The absence of symptoms is more particularly marked in simple gummata which exist in the capsule or in the substance of the liver and do not obstruct the bloodvessels and biliary ducts. In all such cases more or less anæmia and cachexia are present. The liver is nearly always enlarged and the surface may be smooth, but it commonly presents irregular nodules varying in size, some of which may be so prominent as to press forward the integument. The lower margin of the liver may be found as low down as the crest of the ilium. It is more or less rounded and presents nodular elevations. The hypertrophy is often irregular. The left lobe may fill the greater part of the epigastrium, whereas the right may remain normal. The nodules are hard, and the furrows between them may be felt through the skin. Thierfelder states that one has rarely the opportunity of demonstrating the gradual reduction in size of the liver when the patient is under treatment, and that lesions continue to present the same physical signs even after the patient has for a long time taken antisyphilitic remedies. The following case, which has been under my observation during the past year, would seem to be an exception: The patient, a female fifty-three years of age, entered the Toronto

General Hospital in October complaining of a feeling of weight and dull pain in the hepatic region. Physical examination revealed an unequal enlargement of the liver. The lower margin of a nodule in the median line extended to within an inch of the umbilicus; the surface was somewhat roughened, and the patient complained of tenderness on palpation. As there were evidences of tertiary syphilis on the skin and a history of that disease was obtained, the patient was put on iodide of potassium. After a month's time some improvement was noticed, and in three months the enlargement had almost entirely disappeared, and the margin of the liver could be felt near its normal position. The enlargement was in all probability due to gummata in the capsule and to perihepatic inflammation. The patient was very anæmic when she entered the hospital. On the iodide of potassium alone, without either iron or arsenic, the improvement was most marked. There was a decided increase in the number of red corpuscles and of the hæmoglobin.

When the liver is much enlarged a feeling of weight and discomfort may be experienced in the hepatic region. Pain of a severe and continuous character is sometimes present, and Frerichs has reported a case in which it lasted for months. Tenderness is frequently present in the right hypochondrium. Pain in the right shoulder is often complained of if the perihepatitis is marked. Ascites is not often found in hereditary syphilis, but when present is due to an occlusion of the portal vein by the presence of nodules in the capsule of Glisson. Although the amount of fluid is not abundant, cases have been recorded in which several pints have been drawn off. The subcutaneous vessels in the abdominal wall are also at times dilated, and hemorrhage occasionally takes place from the mucous membrane of the stomach and intestines. The spleen is generally enlarged when there is ascites, and albumin is often present in the urine. It will thus be seen that although ascites is less frequent and the amount of fluid less abundant than in alcoholic cirrhosis, in occasional cases all the characteristics of hydroperitoneum due to the latter cause may be present. In the syphilitic form the fluid returns after paracentesis, and its return can only be prevented by antisyphilitic treatment. Chylous fluid has occasionally been observed, perhaps as the result of pressure on the thoracic duct. Jaundice is not common, and when it exists the coloration is not usually deep. The skin may be pale, slightly yellow, and in a few cases somewhat bronzed. The jaundice already mentioned as occurring in the secondary stage of syphilis may be due to the action of the syphilitic virus on the hepatic cells and the smaller bile ducts. As has been demonstrated hy Jonathan Hutchinson, there are occasional cases of syphilis which run a rapid course, and tertiary lesions may appear within a year. In such cases jaundice, though appearing early, may be due to the presence of hepatic gummata.

The spleen is often enlarged from the presence of gummata or from amyloid degeneration. Pain and tenderness are sometimes experienced in the splenic region.

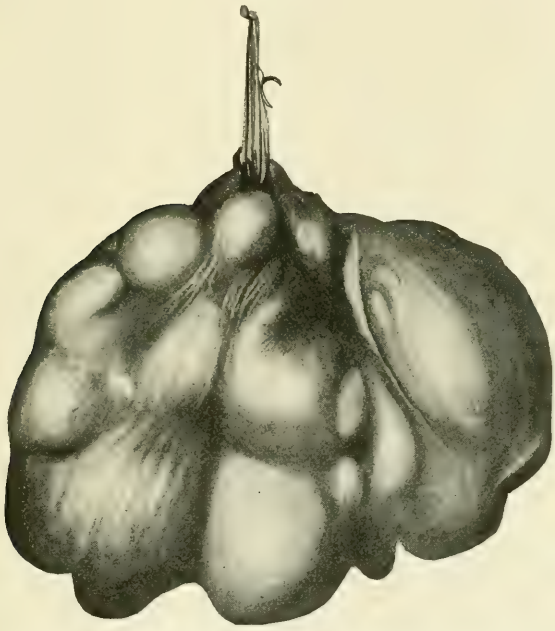
Syphilitic lesions are often found in other parts of the body, such as the skin, the lungs, or the central nervous system.

Pathological Anatomy.—Cicatrices on the surface of the liver are not infrequently found in those who have suffered from syphilis.

They form depressions on the convex surface which on section appear to be made up of fibrous structure. Cicatrices which do not reach the surface are occasionally, but not often, present in the substance of the liver. The diffuse form is seldom noticed in adults, although Wagner observed it in a man fifty-four years of age.

Syphilis in the liver of the adult exists usually in the sclero-gummatous form, and the amount of diffuse cirrhosis varies in proportion to the nodular elevations. The shape of the liver is often much modified. One part may have undergone atrophy, while another becomes much hypertrophied. Sometimes the surface is divided into lobules by deep furrows, at the base of which cicatricial tissue is seen. The nodules may vary in size from that of a bean to that of a walnut, and the structure resembles that of syphilitic gummata in other situations. In one case mentioned by Frerichs the left lobe was shrunken and appeared

FIG. 30.



Showing the extreme irregularity of a syphilitic liver (Osler).

as an appendage; in another the right lobe was diminished to half the normal size and the left was much hypertrophied. The organ, as a whole, is generally enlarged. In 4 of Frerichs' 17 cases it was reduced in size, in 7 it was normal, and in 6 it was enlarged. In 5 of the latter waxy degeneration was present.

The hepatic tissue between the nodules shows signs of fatty degeneration. Sometimes there seems to be an increase in the size of the lobules, but, as a rule, there is a loss of liver substance near the cicatricial tissue. The nodules may exist in any part of the liver, but are commonly found near the suspensory ligament and in the alveolar tissue in the portal fissure. There may be evidences of perihepatitis in

the form of adhesions to the surrounding organs which produce constriction and deformity. On account of the adhesions it is often difficult to remove the liver. The change in shape may be very marked, often globular and often segmented. The capsule is much thickened, and bands may be seen continuous with the capsule entering the liver, producing one form of cirrhosis. The cut surface of a large nodule presents a central portion with an irregular, jagged outline, which is made up of fine fibres, partly destroyed cells, and fat globules. The surrounding part consists of dull glistening tissue and is rich in blood-vessels with thickened walls. The gummata are at first very vascular, but the vessels gradually disappear, and for this reason degenerative changes take place in the centre.

Course and Duration.—The disease comes on insidiously, and it may at first present few symptoms. Rindfleisch was of the opinion that some cases of cirrhosis in the adult were of hereditary syphilitic origin, in which the condition remained latent until middle life. The course is usually chronic, and the disease may last for years unless the patient is placed on proper treatment. Jonathan Hutchinson has reported a case cured after thirty tappings of the abdomen had been made. Grainger Stewart reports a case in which a cure took place after the patient had been tapped twenty-one times and an enormous quantity of fluid had been drawn off. The termination will often depend on the extent to which the portal circulation is obstructed and the amount of destruction of the parenchymatous structure.

Prognosis.—Syphilis in newly-born children is very fatal: infants often die at birth or when two or three days old. Some may last for two or three months, and a few make a complete recovery.

In the acquired syphilis of the adult the prognosis is usually favorable. The disease, even after it has been a long time in existence, may be cured by proper treatment.

Diagnosis.—The curability of the syphilitic compared with some other enlargements of the liver should stimulate the physician to make a correct diagnosis.

In the newly born and in young children the diagnosis is not difficult. The history of syphilis in the parents, the presence of the various lesions already mentioned, as well as the emaciation, will cause the physician to make a careful examination of the liver, when he may find enlargement and nodular elevations. Fournier has pointed out the fact that syphilis of the liver of an hereditary character may occur later in life—syphilis hereditaria tarda. The diagnosis of syphilitic liver in the adult may not be difficult when there are evidences of the disease in other parts of the body, such as ulcer and cicatrices of the skin or the presence of brain trouble. When these evidences are not found the nature of the enlargement should be ascertained. According to Lancereaux, the nodule of syphilis has less firmness than that of carcinoma. He was also of the opinion that the increase in size of the left lobe occurred oftener in syphilis than in carcinoma. The age of the patient may also be of some assistance. The spleen is nearly always enlarged in syphilis, whereas the change in the size of this organ can scarcely be noticed in cancer of the liver. Albuminuria occurs much more frequently in syphilis than in carcinoma.

The diagnosis between syphilitic and alcoholic cirrhosis is sometimes difficult. The cases of atrophy of the liver from syphilis are not common, and the enlarged or the gummatous variety is not difficult to differentiate. The nodules are larger. When in syphilitic liver the ascites is great the condition of the organ may be obscured. The previous history of the case or the presence of syphilitic lesions elsewhere may help the diagnostician to arrive at a correct conclusion.

Treatment.—When pain and tenderness are marked the patient should remain in bed and warm applications should be made for his relief. The diet should be restricted to milk and farinaceous food, vegetables, and animal broths, a moderate amount of meat, and fish. The iodide of potassium should be given, beginning with moderate doses and increasing to twenty or thirty grains three times a day. Harley does not recommend the use of mercurials, but relies on the iodide in the form of the iodide of ammonium. Inunctions of mercurial ointment (green iodide) over the surface of the liver have been recommended.

FATTY LIVER.

Fat is always present in the hepatic cell, and the amount may be increased or diminished to a considerable extent in normal conditions. When it exists in excess, without any diminution of albumin, the condition is usually termed "fatty infiltration," and when it is formed at the expense of the protoplasm it is designated "fatty degeneration." As has been pointed out by Von Schüppel, cases occur in which the fat is formed at the expense of the albumin, but the latter is replaced from without, so that the cell contains the normal quantity. Such cases do not differ materially from those of "fatty infiltration." The term "fatty degeneration" is usually applied to the lessening of the amount of albumin, when the cell undergoes atrophy. It was thought at one time that these two conditions could be distinguished from one another by microscopical examination—that in infiltration the fat existed in globules, whereas in degeneration it is in a granular form. Latterly, however, it has been shown that in fatty infiltration the fat may exist in the cell in the form of granules as well as that of globules. In healthy conditions the liver is a storehouse for fat, where it is temporarily deposited after a meal, to be given off as it is needed by the system. Fat is formed in the cells and does not exist in the capillaries. As the result of overfeeding an excessive amount may be formed in the cells, especially after the ingestion of fat and carbohydrates. This process is favored by sedentary habits. The reabsorption of fat may be retarded by the low pressure of the hepatic circulation. Apart from this, a healthy condition of the hepatic cell would seem to be necessary to the proper storing up and giving out of fat in the animal economy. Its accumulation in the liver in some wasting diseases may be partly explained as above indicated. When in the normal condition the fat is reabsorbed from the cell, part no doubt passes into the blood and part into the bile.

Etiology.—The experiments of Majendie, Frerichs, and Orth have proved that the amount of fatty infiltration of the liver depends on the quantity of fat and carbohydrates taken in as food. Although it may

not be proven that fat is directly formed from carbohydrates, it is a matter of experience that when these are taken in in large quantities there is an increased deposition in the liver as well as elsewhere. Fatty liver is then found, together with obesity, and a fatty infiltration of the heart muscles, which latter may cause symptoms of cardiac weakness.

Chronic Alcoholism.—The liver often becomes extremely fatty in those who indulge in spirits to excess. In such cases there is frequently an increase of connective tissue—fatty cirrhosis. Alcohol lowers the process of oxidation and diminishes the amount of carbonic acid given off. The process of digestion is at the same time disturbed and the bile-producing function of the hepatic cell interfered with. Frerichs found a fatty liver in 6 out of 13 cases of delirium tremens. More or less fatty degeneration of the hepatic cell is found in many of the acute diseases—puerperal septicæmia, pyæmia, erysipelas, typhus and typhoid fevers, and variola, especially the hemorrhagic form. It is probable that the changes in the liver are the result of toxins.

Charrin (Chauffard)[1] produced fatty liver and kidneys in the cat by the injection of toxins resulting from a culture of bacillus pyocyaneus. Roux and Yersin obtained similar effects in the rabbit by the injection of variola-poison. Phosphorus produces a fatty degeneration in which large globules of fat are formed in the hepatic cells. In acute yellow atrophy a fatty degeneration also takes place, which is soon followed by destruction. Sometimes the accumulation of fat in the liver cells is the result of a local process. The best example of this is the nutmeg or the cardiac liver. Owing to the long-continued venous congestion the fat resulting from the breaking up of the albumin remains in the cells, because the oxidation is incomplete and the hepatic blood current is of extremely low pressure. A localized fatty degeneration also exists in the neighborhood of cancer nodules.

Fatty changes in the liver are found much more frequently on the post-mortem table than one would suppose, because the minor grades of fatty liver do not produce any symptoms whereby they can be recognized. The proportionate number of cases of fatty liver varies very much in different statistics. In 466 bodies Frerichs found fatty liver of the highest grade—*i. e.* fatty throughout—in 28 cases, and an increased amount of fat in 164 cases. A greater number of females than males were affected. The condition existed also in persons who died from accidents and who had previously been quite well. Fatty changes have been found in various diseased conditions, but in none so frequently as in tuberculosis. In 117 cases of tuberculosis the livers were found fatty to an intense degree in 17, and to a less extent, but greater than normal, in 62. In 120 phthisical cases Louis found fatty liver in 40. Chauffard gives the following reasons for the presence of fatty liver in tuberculosis, as quoted from different writers on this subject: (1) Alteration in the gastro-intestinal digestion, so frequently found in tuberculosis. (2) The therapeutical use of oleaginous preparations, especially cod-liver oil, as well as medicines, such as alcohol and arsenic, which are known to produce fatty change. (3) Imperfect oxidation in the lungs. (4) Dilatation of the right side of the heart, producing more or less passive congestion. (5) The reabsorption of fat from the system.

[1] *Soc. de Biol.*, 1890.

Hanot expressed the opinion that the toxins of the tubercular bacillus might produce the fatty change directly.

Pathological Anatomy.—The fatty liver is generally increased in size; it may, however be normal or in some cases atrophied. The whole weight of the organ is increased, while the specific gravity is lessened, sometimes not greater than that of water. The increase in size is uniform; the anterior margin is rounded and thickened. The capsule, which is tense, presents groups of injected veins. While warm the fatty liver feels soft and doughy and is easily curved upon itself. It tears readily under pressure of the finger. The gall bladder is partly filled with greenish stained fluid made up of bile and mucus. The cut surface of the liver presents a whitish appearance and is more or less oily to the touch. A fluid fatty matter can be collected by drawing a knife over the surface. In the most severe forms the lobular structure is destroyed, the whole surface presenting a pale yellow or grayish white appearance; and when the change is less marked the centre of the lobule is not affected and may present a reddish brown color. The amount of blood found in a fatty liver is usually much diminished, largely owing to a post-mortem change. When the pressure of the circulation is withdrawn the overfilled hepatic cells expand and press the blood out of the capillaries into the larger vessels. The fat is at first deposited in small drops or granules near the nucleus; these increase in number and size, coalesce, and thus obscure the nucleus. As this process goes on larger drops form, so that three or four will almost fill a cell. The fat is nearly always fluid, but occasionally it is more or less solid, producing a form which was termed by Rokitansky "wax-like liver"—a condition which is to be distinguished from amyloid degeneration and is the result of the presence of palmitin and stearin. Perls found fat in the intralobular bile ducts, and Platen found it in Küpfer's cells. The accumulation of oil globules causes the cells to enlarge and to become more cylindrical in form. In the most advanced cases it may be difficult to distinguish the cell wall. The disease commences in the outside of the lobule, and gradually spreads inward. Frerichs has divided it into three grades: (1) When the outer zone of the lobule is affected; (2) when it is affected more than halfway toward the centre; (3) when the whole lobule to the hepatic vein is affected. This he calls the highest grade. The proportion of fat to the whole liver substance is sometimes as large as from 76 to 78 per cent., according to examinations made by Frerichs. The organ burns readily with a bright flame. The normal proportion of fat in the liver, according to Perls, ranges between 5 and 7 per cent.

Symptoms.—The prominence of the symptoms of fatty liver depends on the character and extent of the disease. When of the highest grade the liver dulness may be distinctly marked out by percussion, and extends from the nipple downward two or more inches below the costal margin, not usually lower down than the umbilicus. The surface is smooth and the anterior and lower margin round, but does not give the normal resistance to pressure. The form and consistence of the liver are not so evident in patients whose abdominal walls are thick and fatty. The weight of the organ may cause more or less downward displacement, and this, together with its curving upon itself, gives the im-

pression that the liver is larger than it really is. The enlargement differs from that of carcinoma in the fact that, although it may be increased to double its volume, there is little if any bulging out of the lower part of the right thorax. Space is made in the abdomen by displacement of the other viscera.

Ascites is rarely found, and only exists when there is some interstitial hepatitis. The spleen is not often enlarged. Jaundice is not a frequent symptom, and is only present as a result of some complication. Constitutional symptoms are only noticed when there is a high grade of fatty change. The most frequent are want of appetite, vomiting, a tendency to diarrhœa, and the presence of hemorrhoids.

Sometimes the passages from the bowels are lacking in coloring matter, have a fetid odor, and may contain blood. Flatulence and discomfort are present after taking food. When there is much increase in the size of the liver a feeling of weight may be experienced, with uneasiness and sometimes pain in the epigastric regions. Addison was of the opinion that the integument presented a bloodless, almost semi-transparent, waxy appearance, often with a sallow tinge, and that in some cases it felt smooth and loose, and in others soft, conveying a sensation resembling that experienced in handling a piece of the softest satin. Murchinson remarks that this condition is present more often in females, but is frequently absent. Von Schüppel was doubtful if it was directly caused by fatty liver. The pulse may be soft, compressible, and very feeble if the cardiac muscle is much involved. Fatty heart is more frequently found in patients suffering from obesity who take large quantities of food and exercise little.

Course and Duration.—Leaving out of consideration those forms of fatty degeneration due to poison or infective diseases, such as acute yellow atrophy, fatty liver runs a chronic course even in its highest grade. The functions of the organ do not seem to be much interfered with nor life much shortened. The course and duration are much influenced by the complications which are so frequently present, such, for instance, as fatty heart and fatty kidneys.

Pathology.—Even in the highest grade of fatty liver there is not sufficient obstruction to the portal circulation to produce ascites. There may, however, be sufficient to cause some congestion of the gastro-intestinal mucous membrane, and this would be more likely to occur if the heart is involved. In the more marked cases the amount of bile excreted is diminished, as shown by its absence from the gall bladder and biliary passages after death. Frerichs was not able to find any change in the bile excreted other than loss of color from increase of water. He did not find any increase of fat, any albumin, or any peculiar odor, such as that described by Addison. Bidder and Schmidt discovered that in the case of animals in which fatty liver was produced by feeding the bile was diminished in quantity and resembled that of starving animals. Lereboullet (Frerichs), who made observations on the fattening of geese, found that after nine days' feeding the gall bladder was distended with liquid containing a moderate quantity of oil globules. After twenty-eight days only a very small quantity of oleaginous bile was present. Von Schüppel was of opinion that the bile from a fatty liver could not be distinguished from that of health.

The glycogenic function does not seem to be interfered with. In the most extensive form of the disease so much of the parenchyma is destroyed that the metabolism of sugar must be interfered with, so far as the liver is concerned.

Diagnosis.—It may be impossible to diagnose the lower grade of fatty liver. The uniform enlargement, the smooth surface, the rounded border, and the want of solidity are the most prominent signs, which, when found without ascites, enlargement of the spleen, or jaundice in an obese patient, render the diagnosis of fatty liver very probable. Should a similar condition be found in cases of pulmonary tuberculosis, it is probably due to fatty change. The amyloid liver may be differentiated by its hardness and resistance and the distinctness with which the margin may be felt. In this form, too, the spleen is usually enlarged from the same deposit, and the kidneys also may be involved. Ascites is frequently present, and the amyloid degeneration of the kidneys may tend to albuminuria and general anasarca. An enlargement of the liver from fatty degeneration, combined with cirrhosis, is a condition frequently met with, and may be distinguished by the greater firmness of the organ, the roughening of the surface, and the presence of ascites, with splenic enlargement. The enlargement of leucæmia may be distinguished by the presence of leucocytes in the blood, greater enlargement of the spleen, and other signs of the disease. A leucæmic liver is much harder and the margin more distinctly felt than that of the fatty type. The condition known as cloudy swelling, the result of infectious diseases or intoxication, is accompanied by an enlarged liver with a smooth surface and more or less want of consistency. The presence of the disease or intoxication may aid in the differentiation, and the appearance of casts and albumin in the urine would indicate the probability that the kidney structure is being acted on by the same poison as the liver.

Treatment.—The object of the treatment of fatty liver should be, if possible, to remove the cause. In case of obesity the amount of fatty and saccharine food should be limited and the diet should be largely of an albuminoid character. Meat, fish, green vegetables, and plain broths may be given. Stimulants, especially beer and sweet wines, should be avoided. The patient should be advised to take regular exercise, which ought to be moderate at first and be increased as the patient seems able to endure it and shows signs of improvement. When there are symptoms of fatty heart care should be taken that the diet is not changed too suddenly or too great an amount of exercise indulged in. The withdrawal of all stimulants in such cases may be followed by unfavorable symptoms. When fatty liver occurs in connection with pulmonary tuberculosis special treatment may not be indicated, except the withdrawal of cod-liver oil and oleaginous food. As a rule, phthisical patients who suffer from fatty liver have so much gastric and intestinal indigestion that such articles of food would be at any rate contraindicated. Alkalies and alkaline carbonates have been recommended, given with some vegetable bitter, as gentian or taraxacum. Rhubarb, colocynth, or aloes may be given for the constipation. Murchison recommends the ingestion of large quantities of common salt. Carlsbad, Vichy, Kissingen, and Congress waters have been also recom-

mended. In case of marked anæmia iron is of great service, and in pernicious anæmia arsenic may be given. Intestinal antiseptics will be necessary if there is much flatulence. Ox-gall pills, salol, salicylate of soda, and benzo-naphthol have all been prescribed for this condition.

EMPHYSEMA OF THE LIVER.

A CONDITION has been described by French writers in which the liver contained gas. The organ gave a clear sound on percussion, and portions of it floated on water. The gas may arise from local disintegration or perhaps from the presence of a gas-forming bacillus. Heintze of Cologne has reported a fatal case of cholelithiasis with formation of gas in the liver, produced, the author believed, by the bacillus coli communis, which is known to possess the property of forming gas in certain media. A bilateral pleurisy secondary to the cholelithiasis existed in the same case. The bacillus aërogenes capsulatus may be cause in some cases.

AMYLOID LIVER.

AMYLOID degeneration of the liver is part of a general process in which the spleen, kidneys, and intestines are also involved. Amyloid matter is not, as it was at one time supposed to be, of a chemical composition similar to starch. Its peculiar reaction with iodine gave rise to that idea as well as to its present name. It contains nitrogen, and it was thought by Dickinson to be dealkalized fibrin. It has more recently been considered an albuminoid substance which when disintegrated splits up into leucin and tyrosin. It resists decomposition much longer than albuminoid matter generally. The deposit of amyloid matter is always a secondary process, and the primary condition is usually connected with chronic suppurative disease—tuberculosis or syphilis. Tuberculosis is the most frequent primary disease, and this is often combined with suppuration. Pulmonary tuberculosis is often the cause, especially the ulcerative variety, when large cavities are present or when there is ulceration of the larynx and trachea. Tuberculosis of the intestine is also one of the more frequent primary diseases.

According to Von Schüppel, primary tuberculosis of the genito-urinary tract is not followed by amyloid disease even when accompanied by extensive ulceration and suppurative pyelitis. The tubercular bone and joint inflammations, caries, white swelling, Pott's disease of the spine, and large tubercular abscesses connected or not with bones, have also preceded amyloid disease. Bartels has remarked that amyloid degeneration does not occur so frequently when there is free access of air to the abscess cavity, probably because a new form of fermentation is thereby induced. Empyemata, large ulcerations of the leg, tubercular as well as syphilitic, and fistulous openings through soft parts have all been reported as primary diseases. Malaria, leucocythæmia, pseudo-leucæmia, rickets, and gout have been followed by lardaceous degeneration when there was no suppuration.

Amyloid infiltration has been found in cases of hereditary as well as acquired syphilis, and, although ulceration of the skin and mucous membranes and diseased bone are frequently present in such cases, waxy deposit will take place when these conditions are absent.

Waxy liver has been found in a number of cases when no primary disease, such as has been described, was present. It is probable that in such cases the constitutional dyscrasia existed, or rather that some form of toxin circulated in the blood which eluded observation and acted as the primary cause.

Age.—Amyloid disease may be congenital, and it has been found at all ages from two to seventy years, but it occurs most frequently between twenty and thirty.

Sex.—In Frerichs' 68 cases 53 were in men and 15 in women, and in Wagner's 48 cases 35 were in men and 15 in women. It is difficult to understand why there should be such a large proportion of male cases, since the primary conditions which give rise to amyloid disease occur as often in women as in men.

The true character of this change is not known. It is probably produced by a toxin acting slowly upon the walls of the capillaries in some of the more important organs. Virchow and Kyber were of the opinion that it was a regressive process similar to calcareous degeneration. Charrin and Bouchard were able to produce the amyloid change in the organs of rabbits by poisoning them with pyocyanin or by inoculation with tubercular matter. The process is usually chronic, although some apparently acute cases have been reported. Cohnheim reported the case of a soldier who died of amyloid cachexia within a fortnight after receiving a wound which was followed by suppuration.

Pathological Anatomy.—The liver is uniformly enlarged, and may reach an enormous size. Perhaps, next to cancer, it attains in waxy disease its greatest volume. Fagge mentions a case in which the liver weighed eight pounds, and Wilks one fourteen pounds in weight. A good deal of amyloid infiltration may take place when there is little increase in volume. The capsule is smooth and tense; the margin is occasionally sharp, but generally rounded and well defined; the density is much increased, and the specific gravity has been found as high as 1080 (Fagge). The cut surface presents in the advanced stage a peculiar hard, yellowish, glazed appearance, which is more or less transparent, and resembles, according to Frerichs, smoked salmon. When the change is not so marked the amyloid matter may exist in the middle zones of the lobules, and may present a peculiar reddish yellow, transparent appearance, quite different from the surrounding liver structure. When a solution of iodine is poured on the surface the waxy matter is stained a deep red or reddish brown mahogany color. The solution is best made of the following strength: Iodide of potash 2 parts, iodine 1 part, and water 200 parts. When poured over the surface of the liver it should be allowed to stand for a short time, and then be washed off with water. When a solution of sulphuric acid, hydrochloric acid, calcium chloride, or zinc chloride is applied, the color changes to a violet or a violet blue, scarcely ever a clear blue. The reaction is shown best in fresh preparations, and if specimens have been preserved in alcohol, they should be well washed with distilled

water before the reagents are applied. Böttchen recommends the following solution: Iodine .25, iodide of potassium .5, and water 100 parts.

In some cases the amount of amyloid matter may be so small that it can only be recognized by the microscope after staining with methyl-violet.

The gall bladder in extreme cases is found to contain a small amount of bile. The process is best studied in those cases which exhibit slight changes. The earliest infiltration is found in the smallest branches of the hepatic artery, then in the lobular capillaries which communicate with them. It is then found in the branches of the hepatic vein and in those of the portal system. The earliest change, therefore, takes place in the median zone of the lobule, and extends first toward the centre, and then toward the periphery. Hirschfeld found that the media, and then the intima, were first affected in the arteries. In some cases the lumen remains intact, whereas in others it may be narrowed or completely occluded.

The older writers, Frerichs among others, described a process of infiltration into the hepatic cells. Wagner, Hirschfeld, and others have stated the opinion that the hepatic cells were destroyed by pressure and obstruction of the circulation, and that they were never the seat of deposit. More recently Orth, Böttchen, and Eichhorst claim that the cells take part in the process, and that amyloid matter is occasionally though rarely found in them.

Amyloid infiltration may take place in a liver which has already been diseased, and an amyloid liver may take on other pathological changes. Fatty and amyloid infiltration may exist in the same organ. In such cases the fatty change is found at the periphery and the amyloid deposit in the middle zone of the lobule.

In some cases of cardiac liver pigmentary deposit is found in the centre, amyloid in the middle zone, and fatty in the outer zone of the lobules. Added to this, there may be more or less increase of connective tissue.

Syphilitic nodules are sometimes found in amyloid liver. According Von Schüppel, the growth of a tumor in the liver may cause a partial disappearance of the lardaceous matter.

Pathology.—The biliary secretion does not seem to be much affected even in some severe cases of lardaceous liver. It may be normal or it may be thick and present a dark green color. In the most advanced cases, however, as a general rule, the bile is almost colorless or of a light green tint. The biliverdin and biliary salts are diminished. This condition may be accounted for by the great destruction of hepatic cells.

The anæmic state of the liver depends partly on the general state of the system and partly on the obstruction of the capillaries. The glycogenic function is probably affected in proportion to the amount of liver structure destroyed. The nature of amyloid matter has already been referred to. Virchow thought it was chemically allied to vegetable cellulose, and Meckels that it bore a close relationship to cholesterin. Both of these views have been discarded since the discovery of nitrogen in the infiltrated matter, and more recently its disintegration into leucin and tyrosin has demonstrated the albuminoid character of the deposit. It is probable that the change is produced by the presence of a toxin in the blood.

Von Recklinghausen was of the opinion that a homogeneous material was exuded from the cells, which, being bathed in the tissue juices from the blood, swelled up and flowed together, thus becoming transformed into irregular masses.

Weigert spoke of a kind of coagulation through admixture of constituents of tissue elements with the constituents of the blood. The fact that only the connective tissue falls a prey to the disease makes it probable that the tissue elements play an important rôle in amyloid degeneration. Klebs nearly accepts V. Recklinghausen's view, but thinks that a fore-stage of the amyloid is formed in the blood, and that the depression of cell activities favors its formation. Czerny believes that first a pre-existing substance is formed, not in the blood, but in the pus cells, which is deposited in other tissues and becomes transformed into amyloid proper. Ziegler believes, on the other hand, that amyloid arises from the circulating albumins in this way—that the tissue cells are not able to decompose the albumin any longer in the normal way, so that it remains lying here and there and undergoes peculiar modifications. Wichmann looks upon amyloid formation as the result of a depression of the physiological activities of the tissues, so that the albumin normally coming from the blood no longer is assimilated, but remains lying in the tissue spaces, and later, combining with other albumin bodies, suffers especial chemical transformations. Birch-Hirschfeld thinks that at present it is impossible to set up any theory of amyloid degeneration.

Lubarsch says that in propounding a theory of amyloid degeneration three questions must be clearly answered:

(*a*) What are the factors which determine amyloid degeneration? What is common to the different diseases which give rise to it, and do local and general amyloid diseases depend upon the same causes?

(*b*) What is the origin of the amyloid substance?

(*c*) Upon what chemical substances does the specific staining reaction depend?

(*a*) In general amyloid degeneration one can find a factor common to all cases—that is, continued loss of albumin or, as Wichmann has especially emphasized, chronic anæmia, which was also present in such cases where no special cause for the amyloid degeneration could be found, so that the faulty assimilative activity of the tissue cells would be one requirement for the occurrence of amyloid degeneration. As a second factor an intimate bathing of the tissue with fluid is mentioned, through which a kind of coagulation of the parts no longer functioning normally occurred; the absence of such irrigation with tissue fluids would explain why epithelium does not undergo amyloid change even when its physiological activity is completely gone. As in hyaline coagulation, it would appear that for amyloid degeneration several factors are necessary: (1) A definite chemical constitution of the tissue. (2) A special injury of the functional activity of the tissue. (3) An abundant irrigation with tissue fluid. All these factors play a part in local amyloid degeneration.

(*b*) As to the peculiar origin of amyloid, it has been seen above that in some cases hyaline can be a fore-stage, so that the amyloid formation probably stands in a certain connection with the coagulative processes.

It is probable that the aniline-violet reaction represents an earlier stage of amyloid than the iodine reaction. Stilling has shown, further, that there is such a thing as amyloid which will yield the iodine reaction, but will no longer give the aniline-violet reaction, and it is also probable that there is such a thing as achroo-amyloid.

(*c*) The most difficult question, which from our present chemical knowledge can scarcely be even hypothetically answered, is that regarding the special chemical transformation which determines the amyloid-staining reactions. There are observations which make it seem possible that certain relations exist between amyloid and glycogen, and one could perhaps think of amyloid as a combination of an albumin derivative and some carbohydrate (glycogen-like body). Lubarsch speaks of the difficulties of producing amyloid change experimentally in animals, and says we can scarcely hope for the settlement of the question until our knowledge has become considerably widened.[1]

Symptoms.—The symptoms which arise from the primary disease need not be referred to here.

The amyloid change is so frequently found in other portions of the body, the spleen, kidneys, and intestine, that symptoms arising from these complicate those resulting from the changes in the liver. The condition of the latter may give rise to very few symptoms. The liver is enlarged if there is much lardaceous deposit, but may, however, be smaller than normal if the process takes place in a previously cirrhosed organ. The surface is smooth and firm, and the lower margin is usually rounded and distinctly felt. The fissure is often well marked, and is found to the left of the normal position. When waxy infiltration exists with cirrhosis or syphilitic disease the surface may be rough and nodular. Hepatic dulness is notably increased upward and downward, but more especially in the latter direction. There may be a decided prominence of the abdominal walls in the right hypochondrium, but the ribs are not pressed outward, except in very few cases. The liver seems to displace the organs rather than the diaphragm, but not to the same extent as the fatty form. Pain is not felt in the hepatic region unless perihepatitis or syphilitic disease is present, and firm pressure is usually borne without any sense of tenderness. Murchison reports acute tenderness in one of his cases.

Ascites is not marked, except in some cases of advanced disease or when cirrhosis or syphilis also exists. In the amyloid process the capillaries of the portal system are affected after those of the hepatic artery and vein. This may account for the late appearance of ascites. However, even in the advanced cases, where the portal capillaries are affected, the peritoneal cavity may not contain any fluid. The enlargement of the glands of the portal fissure sometimes by pressure on the veins produces ascites, and waxy degeneration of the kidneys may cause hydroperitoneum as a part of a general anasarca. Enlargement of the spleen occurs in more than half of the cases. This is generally due to a waxy infiltration of that organ, or it may be the result of syphilis, leucæmia, or pseudo-leucæmia, diseases which are accompanied by waxy changes in the liver. Biliary obstruction is not a result of amyloid

[1] *Vide* Krawskow on "Amyloid produced Experimentally in Animals," *Centralbl. für Allg. Path.*, Bd. 6, 337, 1895.

infiltration alone. This disease, therefore, is not accompanied by jaundice unless some complication is present, such as enlargement of the lymphatic glands in the portal fissure. The destruction of hepatic cells results in the lessened production of bile, and this is of an impoverished character. This leads to intestinal disturbance from decomposition of the contents, and the formation of gas causes a greater or less degree of tympanites. The discharges from the bowels may be light colored or at times may become deeply stained. Dyspeptic symptoms—anorexia, nausea, and vomiting—are present in some cases. Diarrhœa is not an infrequent symptom, which may be due to amyloid disease of the intestinal walls or to ulceration of syphilitic or tuberculous character.

Anæmia with some leucocytosis is always present. The countenance is pale and sallow and the patient suffers from greater or less debility. Begbie noticed a disagreeable odor of the skin and breath, which he likened to musty indigo.

The amount of urine secreted is unchanged when the kidney is not affected, but is much increased and contains albumin when waxy change has taken place in this organ. Œdema is often present, the result of kidney disease.

Course and Duration.—Amyloid infiltration of the liver is usually a slow process, extending over months, and the course and duration are materially influenced by the primary disease. When once established the progress is gradually and certainly downward. Death may result from anæmia, from kidney complications, or from some intercurrent affection, as dysentery or pneumonia.

Some difference of opinion has existed as to the possible curability of amyloid disease. Frerichs and Budd have reported cases in which the size of the liver was lessened by appropriate treatment.

Diagnosis.—When the liver is decidedly enlarged, having a firm, smooth surface with rounded anterior margin, free from pain and tenderness, and the patient has suffered from chronic suppurative disease of tubercular or syphilitic origin, the diagnosis is not difficult. If, on the other hand, there is no hepatic enlargement, the amyloid condition may be suspected on account of the presence of waxy disease in other organs —an enlarged spleen, for instance, or an albuminuria.

Enlargement from acute congestion is easily excluded by the presence of general anæmia.

Leucæmia may be excluded by a microscopical examination of the blood.

Fatty liver free from amyloid change is known by its want of firmness and by the pliability of the anterior margin, and it is not, as a rule, accompanied by the same amount of anasarca and debility. The presence of the primary conditions already mentioned will aid in confirming the diagnosis.

Prognosis.—The prognosis is in almost all cases unfavorable. If the liver alone is affected, the duration is longer than if other organs are similarly diseased.

Treatment.—For the reason already given the prevention of the disease is of the greatest importance, and this can only be accomplished by the successful treatment of the primary affection. Patients suffering from chronic suppurative disease should be placed under the most favor-

able hygienic conditions, with abundance of fresh air, sunlight, and good food. At the same time, the most appropriate medical as well as surgical treatment should be adopted. Owing to the improved surgical methods, as well as to the hygienic management of tuberculosis, cases of amyloid disease do not occur now as often as formerly.

Careful attention should be paid to the condition of the skin. Bathing and massage will have a beneficial effect both on the primary and the secondary disease.

The diet should consist of easily digested, nourishing food, and should not contain much fat, farinaceous or saccharine matter. In anæmic conditions iron may be taken, and for the constipation mild cathartics, rhubarb, ox-gall, and aloes, are given. The diarrhœa which sometimes alternates with constipation requires astringents and opiates.

Iodide of potassium is of special service when the lardaceous disease is of syphilitic origin. For the amyloid condition itself Budd recommends chloride of ammonium in doses of from five to ten grains. Frerichs states that he has seen one case of amyloid spleen and kidney from constitutional syphilis in which the symptoms disappeared altogether after the use of the syrup of the iodide of iron. Alkalies have been recommended by Dickinson. Graves reported a case successfully treated with blue pill and iodide of potassium. Frerichs, in writing of the use of carbonate, phosphate, and sulphate of soda, warns against their too free administration, as they may cause exhaustive diarrhœa, and this increases the anæmia. The general anasarca should be treated by purgatives, diuretics, and diaphoretics. Drastic cathartics should be avoided and the fluid removed by the skin and kidneys. These remedies are more urgently necessary if symptoms of uræmia are present. Bitter extracts with nitro-muriatic acid have also been recommended.

PARASITES OF THE LIVER.

Echinococcus.

Synonym.—Hydatid cyst.

Definition.—A disease of the liver cystic in character and due to the presence of a larval form of the tænia echinococcus, causing changes in the size and shape of the organ and many disturbances of function of both liver and adjacent viscera.

History.—The ancient writers, Hippocrates, Galen, Aretæus, and others, recognized large cysts of the liver with watery contents, the nature of which was not known, but which were without doubt hydatids of the liver. History gives us no record of any accurate description of these cysts until the sixteenth or seventeenth century; Bonetus about that time reported a number of accurately described cases. Not until 1760, however, was the parasitic nature of the disease discovered, when Pallas demonstrated their close relationship to tape-worms. A little later Götze proved that the scolices were the heads of embryonic tænia. Bremser in 1821 was the first to describe accurately the human echinococcus.

Natural History, Development, and Pathology.—As indicated in the definition of hydatid cyst, it is a transition form, through

which the tape-worm, commonly found in the intestine of the dog, and called the tænia echinococcus, passes in its development. As in other cestodes, the little six-hooked embryo of the tænia echinococcus reaches, in some way to be hereafter explained, its habitat in man, passes through a most remarkable stage of "bladder-worm" existence, and gives rise thereafter to scolices or nurses. These are the embryonic tæniæ, which in their turn become adult tape-worms, but only when transferred to the alimentary canal of a suitable host, development beyond that of bladder-worm being impossible until such a change in the location takes place. When mature the tænia echinococcus measures from 4 to 5 millimetres in length, or about $\frac{1}{6}$ or $\frac{1}{5}$ of an inch, and consists of a head and three segments, in the last of which are developed male and female sexual organs. The head is provided with four suckers and a proboscis or rostellum surrounded by a double row of hooklets varying in number from twenty-eight to fifty-two. This proboscis is capable of being protruded or retracted by inherent muscular contraction, and it is by means of the hooks that the tænia attaches itself to the intestinal canal of its host. The most common habitat of this parasite is the intestine of the dog, but it has also been found in the wolf and fox. In some countries, as in Iceland and Australia, where hydatid disease is very frequently met with, it is noticeable that a great many of the domestic animals have become infected with tænia echinococcus.

The terminal or reproductive segment is quite as large as the remainder of the parasite, being about 2 millimetres long and .6 of a millimetre in breadth. The process of fecundation is not clearly understood, but, according to Leuckart, it is accomplished by the segment itself. This view is not supported, however, by the researches of other investigators. After impregnation the segment begins to increase very perceptibly in size, and is filled with ova numbering five thousand or more, each containing an embryo. When the embryos reach maturity the segment containing them becomes detached from the anterior portion of the parasite, and is expelled from the intestinal canal of its host either *en masse* or after rupture of its walls and escape of the ova. These are then free, and more commonly ingested by horses and sheep in food or water which has become contaminated. More rarely man is the medium through which the ova pass for further development. When ingested by man it is generally in drinking water or by eating improperly cleaned vegetables that they reach the stomach. On entering the viscus the ovum of this echinococcus tape-worm starts out on a remarkable career of development. The dense shell of the ovum, which is of a somewhat calcareous nature, is first dissolved by the action of the gastric juice and allows the enveloped embryo to escape as a larva or scolex. This is of an oval or globular shape, about twice as large as a white blood-corpuscle, and possesses six small chitinous hooks, with which it makes its way through the walls of the stomach or small intestines. Its course after this varies: it may pass into the peritoneal cavity and either develop there or effect an entrance into one of the solid viscera, more frequently the liver. It may reach this latter organ either by penetrating directly the tissues between the stomach or intestines and the liver, or by insinuating itself into one of the minute radicles of the portal vein and being carried to the liver by the blood in

its course from the alimentary canal to that organ. The latter is the more probable explanation. If the embryo reached the liver by any means other than by the portal circulation, we would expect to find hydatid disease in the other solid abdominal viscera almost as frequently as in the liver. The echinococcus in its migration differs from the cysticercus and the trichina in giving rise to no symptoms. The greater number of the ova are destroyed before leaving the alimentary canal, or we would expect to find hydatid disease more common than it is, and also to find the multiple cysts, but, as a rule, only one passes to the liver. It makes its way out of the bloodvessel through its walls and travels for some distance through the interlobular connective tissue of the liver until its movements suddenly cease. More commonly hydatids are found immediately beneath the capsule of the upper surface of the right lobe, but there is no reason why they should not occur in any part of the organ; and not infrequently this is the case. When the scolex or embryo is arrested in its course, its presence in the hepatic tissue acts as a local irritant, and, instead of remaining solid, becomes distinctly vesicular, being filled with a clear, transparent fluid. The six chitinous hooks of the embryo have become absorbed, and what is now a bladder-worm or cyst is surrounded by a layer of granular matter, the result of irritation, which in course of time becomes an enveloping membranous sac composed of connective tissue with an extremely rich blood supply. This capsule, though closely adherent to the hydatid, is quite distinct from it, and is formed from irritation of the surrounding structures, and is not developed from the hydatid itself. As the cyst grows, so also does this capsule or membranous sac, simply by a process of distention. There is no organic connection between the sac and the hydatid, though the two are in such close contact with each other. Up to this stage the echinococcus in its development is quite the same as the cystic stage of any of the other tænia; for instance, the cysticercus. Later on, however, in the latter only one head or scolex springs from one part of the interior surface of the cysticercus, thus completing its development. In the great majority of cases of echinococcus, instead of a single protrusion, very many develop from the wall of the parasite. The growth of the cyst is very slow, months and even years often elapsing before there are any symptoms to indicate its presence. How long it remains in this stage without the formation of heads or scolices is a matter of doubt. According to Leuckart, probably five months elapse before the bladder attains complete development and begins to give forth heads or scolices from its walls. The cyst is at this time from 15 to 20 millimetres in diameter. It is thus that the existence of a head or a number of heads indicates that the embryo has become an adult echinococcus. As long as these heads live in their larval state they retain their connection with the cyst wall from which they spring and derive their nourishment. The cysts vary in size from that of a millet-seed to that of an orange. Sometimes they attain the size of a human head or even larger: Leuckart records one cyst which with contents weighed thirty pounds. This must be an unusual occurrence, and probably the above limits are not often surpassed.

The cyst wall is at this time made up of an external lamellated cuticular layer of great elasticity and an internal granular or paren-

chymatous layer. The stage of simple "bladder-worm" existence being completed, preparation is made for the development of brood capsules, from the inner surface of which the embryonic heads or scolices arise. At distinct points in the internal granular layer of the hydatid or mother cyst small elevations are noticed. When these growths, which are, in fact, proliferations of the cellular layer, have become so large that their diameter is twice as great as the thickness of the wall from which they protrude, one can notice within them a small round cavity. Both cavity and process continue to grow until the latter has attained a considerable size, perhaps as large as a hazelnut. This brood capsule remains attached to the wall of the mother cyst and the cavity becomes lined with a cuticular membrane. At a point in the wall of the brood capsule the head begins to develop from a hollow bud. This usually appears first almost directly opposite the attachment of the pedicle of the brood capsule, and becomes the scolex or embryonic head. A great many of these rudimentary heads develop in the wall of the brood capsule, and, according to Leuckart, they are sacciform outgrowths from the external layer of the wall of the brood capsules or daughter cysts; it will be observed that the inner or parenchymatous layer of the wall of the mother cyst has become the external membrane of the daughter cyst. These buds or outgrowths from the wall of the brood capsule grow larger and develop four small suckers and a rostellum surrounded by two rows of hooklets. At this time, and sometimes sooner, the head is retracted and its internal or cuticular surface becomes the outer surface. The original outer surfaces, which of course are the same as the outer surface of the brood capsule or daughter cyst, and parenchymatous in character, come together and adhere to each other. This constitutes invagination. Many of these scolices may be developed in the wall of the brood capsule, and as they become more numerous the brood capsule or daughter cyst increases in size. The brood capsule for some time is filled with a clear, transparent fluid. For some time the heads or scolices remain attached to its wall by a pedicle which permits them to float freely to and fro in the brood capsule contents. Sooner or later, however, they become detached, and frequently dead scolices are numerous in the contents of the older and larger brood capsules.

Instead of the first generation of daughter cysts which spring from the wall of the mother cyst, playing the part of brood capsules and producing rudimentary heads and scolices, the same budding and vesicle formation may occur in their walls, giving origin to granddaughter cysts, and these may be the brood capsules from which arise the heads, or the same process may be repeated again. However, in time the process of vesicle formation ceases, and the buds, instead of becoming capsules, develop into scolices which retract within the capsule and invaginate its wall. All echinococci, however, are not destined to pass through the phases of development described above. Sometimes scolices are not formed, perhaps not even daughter cysts arise from the hydatid walls. These were first described by Laennec, and were called by him acephalocysts. At one time human echinococci were believed to have no scolices, but Bremser is credited with proving their existence in 1821, and in 1837, Bright gave a drawing of them in *Guy's Hospital Reports*.

Exogenous Multiplication.—This is a process which sometimes occurs, but not often, however, in human echinococci. It consists in the formation of daughter bladders in the deep layers of the outer cuticle of the mother cyst. These arise not from the outer surface of the mother cyst, but between the deeply seated lamellæ of the outer cuticle. They differ in this respect from the endogenous daughter cysts which arise from the internal parenchymatous layer of the mother cyst. Between two lamellæ of the outer cuticle there is a deposition of granular matter which becomes enveloped in a secondary cuticle. There is then a development of another series of lamellæ, which surround a central vacuole which continues to grow in proportion to the walls enclosing it. This cavity is filled with a clear transparent fluid. This daughter bladder forces its way toward the surface of the hydatid as it grows larger, until at last the outer layers of the parent cyst succumb to the extreme tension and allow the smaller one to escape into the surrounding tissues. Here it becomes enclosed in a fibrous envelope, as did the embryo from which the mother cyst developed, and proceeds to enter upon the same life history as its parent, producing brood capsules and scolices. A hydatid cyst with such exogenous proliferation presents a remarkable appearance. On its surface will be seen daughter bladders in all stages of development. Some are already detached, leaving scars in the outer cuticle. Others bulge out the external layers, causing the originally spheroidal mother cyst to lose its globular shape and to become very irregular in form, and, again, others about the size of pea, studded all over the outer surface, may produce a marked unevenness.

It will be seen that in such cases as these with exogenous formation of daughter bladders, instead of a single hydatid containing brood capsules and scolices, there may be a great many cysts in the liver, and even the neighboring viscera may be invaded. In Guy's Hospital a case came under the care of Dr. Rees which on post-mortem exhibited abundant hydatids in the liver, diaphragm, and right lung. They were proliferating by external gemmation.

Multilocular Hydatid.—By exogenous proliferation there is another rather remarkable variety of echinococcus formed. The tumor is hard in consistence and somewhat globular in shape. When cut into it is found to be traversed by fibrous trabeculæ which divide the growth into a number of small irregular cavities, each containing either a mass of colloid matter or clear thick fluid. These alveolar contents are found to be made up of hydatid membranes firmly pressed together, and small cysts not larger than peas containing scolices. On account of the alveolar texture of the growth at one time it was described as alveolar colloid of the liver. Virchow demonstrated the fact that these colloid masses were composed of small hydatid cysts. The centre of a multilocular cyst breaks down and a suppurating cavity is often found, and jaundice may have preceded death.

The fluid in the cavity of a hydatid cyst is clear and transparent, with a specific gravity varying from 1006 to 1014, and, unless rendered alkaline by the presence of bile, is of neutral reaction. Unless there is an admixture of blood the fluid is non-albuminous. There is a small percentage of sodium chloride; also traces of the earthy compounds of succinic acid and inosite are found. Urea, creatine, and hæmatoidin

are occasional constituents. How long a human ecchinococcus may retain life and the circumstances which cause its death are questions not easily answered. Some authorities say that when its growth is interfered with by calcification of its ectocyst or outer lamellated wall death of the parasite and contained brood capsules is the result. At one time it was supposed that the daughter cysts and scolices very soon became detached by their respective pedicles becoming broken, and that they were capable of movement in the fluid. This is not the case, for as long as they continue to live they retain their connection with the parent cyst, only dead scolices being found free and without attachment. Cases are recorded in which an echinococcus has existed for thirty years or more, and living scolices in abundance are found on post-mortem examination.

Etiology.—The occurrence of hydatids of the liver in man can only be explained in one way. When we take into consideration the natural history of the tænia echinococcus, it is evident that all who suffer from hydatid disease have in some way become infected by the eggs or proglottides of the tænia. Although the tænia echinococcus has been found in the intestinal tract of the wolf and fox as well as in that of the dog, the latter is the animal especially infected and the one with which man most frequently comes into close association. It may be safely concluded that the great majority of cases in man arise from the ingestion of eggs or proglottides which have been expelled from the alimentary tract of their host, the dog. In some countries, as in Iceland, where the dog shares the food, lodging, and sometimes even the bed, of his master, the eggs and proglottides may reach the stomach *per vias naturales*, being carried to the mouth either in food or on the hands. Often the infecting agent may gain an entrance to the body of its future host from the tongue of a dog which is fond of licking the hands and face of his master. Where dogs have access to slaughter-houses and similar places they often eat portions of echinococcus cysts. This helps to propagate the disease. Man may swallow the eggs or proglottides in drinking water which has become contaminated by the excreta of dogs or by eating vegetables which have not been properly cleaned.

Scolex-bearing cysts have been found in the livers of many animals, as the goat, sheep, ox, and horse, and it must not be forgotten that man may become infected by eating the livers of these diseased animals. Heller has supposed that the scolices on reaching the intestine of man may become attached to its wall, develop, and auto-infection result. This has not been proven, and the presence of tænia in the human intestine has not been demonstrated. By this theory Richardson has explained the prevalence of hydatid disease among shepherds in Victoria, South Australia. Mutton from sheep which have contracted the disease from shepherd dogs may be used as food, and the echinococcus result in one eating it. The possibility of such an occurrence should be remembered. Although the hydatid disease is most prevalent in such countries as Ireland and Australia, where there are special conditions favorable to its propagation, cases are occasionally found in many countries. Osler collected 85 which occurred in the United States and Canada.

Symptoms and Physical Signs.—A hydatid of the liver may be in process of growth for many years without giving rise to any appreciable inconvenience. It is probable that its presence is not suspected in some cases, and in a great many more not diagnosticated before death. This is more especially true of the small and medium-sized tumors. Very often the patient suffers neither from local manifestations of the disease nor from disturbance of function in either liver or other viscera until the growth has attained some considerable size. The greatest number of cases of hydatid disease have been discovered in autopsy. Only 13 cases out of 22 were diagnosed during life in the Berlin Charité. The first symptoms which may lead a patient to seek advice is usually a bulging out in the region of the liver. The presence of tumor is suspected, and there is an apparent enlargement of the organ. Palpation in different cases gives different sensations. In some cases the growth is firm and tense and appears to be solid; in others it is soft and fluctuation may be elicited. The tumor is usually smooth and globular, but sometimes irregular in shape. Under some circumstances, when the hydatid is large and contains a great many daughter cysts, and when the abdominal walls are not too thick, percussion brings out a peculiar sensation which Briançon first described and called the *frémissement hydatique*. It is elicited by grasping the tumor with the left hand and striking it abruptly with the middle finger of the right hand. To the other fingers of the left hand a peculiar vibratory sensation is conveyed, which was supposed by Briançon to be caused by the daughter cysts colliding with each other as they floated in the fluid. By some the sensation is compared with the quivering of agitated jelly. This was supposed to be diagnostic of echinococcus, but it is only present in about one half of the cases, and may also be observed in ovarian tumors and ascites. In deeply seated and solid hydatid tumors it is absent. Briançon's explanation as to the origin of the sensation is hardly tenable, for it is found in cases where daughter cysts are absent.

When the cyst is large there may be a great deal of distress caused by the weight and dragging sensation, but, according to some authorities, actual severe pain is not often experienced. Finsen, however, with a large experience extending over some 245 cases, gives it as an early and a frequent symptom. Bamberger states that some cases present no symptoms referable to the liver until late, while others are attended with sharp pain and more or less pressure from an early stage in the disease.

Pressure of a large echinococcus upon adjacent viscera will produce a series of symptoms common to many cases of abdominal tumor. Some of these are disturbances of respiration, circulation, and digestion. Dyspnœa may be marked; indigestion, vomiting, and constipation are frequently met with, often cardiac palpitation is a marked symptom, and later we may have varicose veins. The patient may live a great many years without any special indication of ill health before these pressure symptoms begin to manifest themselves on account of the size and position of the growth.

Course and Modes of Termination.—In the event of death not taking place from any intercurrent affection, the future course of a hydatid may vary a great deal in different cases according to the

changes which take place in the cyst itself. In time, as the growth enlarges, the case may terminate by one of the following methods: 1, death of the echinococcus; 2, suppuration; 3, rupture of the cyst.

1. *Death of the Echinococcus.*—The echinococcus may die and recovery result, the sac remaining in the liver and the contents becoming absorbed or calcified. This is the most common termination, and there is no doubt that a great many hydatids terminating in this happy way are never diagnosed until they are met with in the post-mortem room. Some have claimed that the growth may also disappear from the sac, rupturing into one or more of the larger bile ducts, without giving rise to symptoms by which the occurrence could be detected. The circumstances which determine the death of the cyst are not very well understood.

2. *Suppuration.*—When a hydatid becomes inflamed and the condition of the patient indicates the onset of suppuration, the clinical picture is quite different from that of the earlier stages of the disease. This is not by any means an infrequent mode of termination. If the tumor can be felt, the onset of inflammation in the cyst will be marked by tenderness on pressure and increased tension over its surface. Pain, if absent before, is generally severe now, though in some cases the whole process of suppuration may be passed through without much pain. The general health, perhaps not at all affected before, begins to suffer. The symptoms are now those of pyæmia, such as rigors, irregular temperature, sweats, and loss of weight. Death results in the majority of these cases, but spontaneous recovery has followed perforation through the abdominal walls into the stomach and intestines and bile duct.

3. *Rupture of the Cyst.*—This may occur with or without suppuration. Rupture may in some cases be the cause of the suppuration; in others the cyst may be old and suppurating at the time of rupture. The symptoms which follow rupture depend upon the direction of the perforation. The most favorable results are observed in those cases in which the opening is through the abdominal wall. Rupture into the stomach or intestines is followed by severe pain and the expulsion of a large quantity of fluid in which are found many vesicles. Often marked tympanites is noted. A great many cases of this kind recover. Cayley reports one in which perforation took place into the bile duct. There were intense jaundice and a great deal of paroxysmal pain, not unlike that caused by the passage of gall stones. In the last attack the cyst was expelled and recovery ensued.

Sometimes the cyst ruptures into the peritoneum, not always spontaneously, but more often as a result of injury. Fatal peritonitis is the rule when this occurs, but there are at least two cases on record where this rupture of a hydatid cyst into the peritoneal cavity resulted in recovery, although for some time afterward the presence of fluid was detected in the lower part of the abdominal cavity. Peritonitis is less likely to follow when the cyst has not been very large, when the injury has not been great, when the escape of fluid into the peritoneal cavity has been gradual, and when the growth has been an acephalocyst. Severe injury, large amount of fluid, and numerous daughter cysts and scolices passing quickly through a large aperture, on the other hand,

rarely fail to result either in death from shock or in the development of an acute peritonitis. When the hydatid is on the upper and posterior surface of the liver the direction of perforation is toward the thoracic cavity. Frequently—in fact, generally—in these cases the echinococcus has not been diagnosed either before or after rupture, as it cannot be reached by palpation. Sometimes rupture into the right pleural cavity takes place and sets up an acute pleurisy. Severe pain and shock are experienced when this accident occurs. Generally pleuritic adhesions are present before rupture, and the perforation in such cases extends directly into the lung. The contents then sometimes make their way into a bronchus and are expelled externally. Hilton Fagge refers to three cases, reported by different physicians, in which hydatid cysts were expectorated after rupture in this way.

Occasionally hydatid cysts rupture into the pericardium, sometimes into the hepatic vein within the liver or into the inferior vena cava, passing directly into the right side of the heart. Sudden death results, without previous symptoms of impending trouble.

Diagnosis.—Hydatid cysts may be mistaken for other affections of the liver, as cirrhosis, abscess, amyloid disease, cystic sarcoma, cancer, and syphilis, also for hydro- and pyo-thorax, distention of the gall bladder, cystic disease of the retroperitoneal glands, aneurysm of the abdominal aorta, and hydronephrosis.

On the first appearance of symptoms referable to the liver it may be very difficult, and even impossible, to exclude all of the other various affections with which hydatid may be confounded. A cystic tumor in the substance of the liver which can be detected by the usual methods of physical examination, and which has grown slowly and without much pain, is probably hydatid of the liver. Very often, indeed, all of the foregoing conditions are not present. With cancer of the liver severe and lancinating pains are generally present, and the growth is nodular in character. Pain may also be severe in hydatid, and be caused by the inflammatory process which may have set in when it has come under observation. The presence of the very marked cachexia and of cancer in other viscera would help the physician to come to a conclusion.

Multilocular hydatid can be rarely diagnosed. Lardaceous liver is extremely hard in character, and the coexistence of wasting disease or long-continued suppuration, with the waxy hue of the skin, would be suggestive. In syphilitic liver there are evidences of the disease elsewhere. In this condition the immobility of the organ is given as a diagnostic sign. This is due to adhesions on the surface which are commonly present.

When a large hydatid cyst is situated near the upper convex surface of the liver and extends upward beneath the ribs, causing some bulging of the intercostal spaces, pleurisy with effusion may be suspected. The upper limit of dulness by careful observation will be found to descend posteriorly as it passes to the spine in cases of hydatid, whereas in pleurisy the level of dulness is horizontal when the patient is in the erect position, and, unless encysted, changes with the movements of the body. A pleuritic effusion is usually preceded by acute pain, fever, cough, and dyspnœa, and is often associated with cardiac, renal, or pulmonary dis-

ease. Pneumo-thorax may also be traced to some apparent cause, and as in hydro- or pyothorax the development is rapid, whereas in hydatid disease months, and even years, are required before the physical signs are developed. In all doubtful cases paracentesis and examination of the fluid would settle the difficulty. The character of hydatid fluid, clear, transparent, or slightly opalescent and non-albuminous, differs from any other found in the thorax or abdomen. When scolices are found there is no room for hesitation as to the condition present.

In cirrhosis of the liver the enlargement is only temporary, and is often accompanied by ascites and enlarged spleen. The habits of the patient are to be considered. In abscess of the liver acute symptoms, such as pain and tenderness on pressure, fever and chills, are prominent enough to enable one to arrive at a diagnosis. In cases where the hydatid cyst protrudes greatly from the under surface of the liver it may be mistaken for an enlarged gall bladder without jaundice, but we seldom have so marked a distention of the gall bladder. In hydronephrosis the growth would be lower down and situated more posteriorly than in hydatid. The colon would be made out on percussion in front of the kidney, whereas when a large hydatid descends the colon is usually pushed behind the growth.

Cystic enlargement of the retroperitoneal glands is not often a source of trouble in diagnosis. In some cases the liver may be adherent to, and its boundaries encroached upon by, a smooth, globular fluid mass, giving the idea that the case is one of hydatid, but an exploring needle will soon determine the nature of the fluid. An abdominal aneurysm can usually be excluded by its position, outline, and pulsation. A mistake might occur when a distinct pulsation was transmitted by a hydatid resting upon the abdominal aorta. Where operative measures are under consideration it is very essential that it should be determined whether the cyst is single or multiple—whether there is exogenous or endogenous proliferation. Where one single globular growth is made out the diagnosis is easy. Where two or more growths are detected, and when only one disappears on aspiration, we may be sure that we have to deal with a case of multiple hydatid. This is equally true if only a small amount of fluid can be withdrawn and there is comparatively little change in the size of the growth.

Prognosis.—The prognosis of hydatid of the liver depends very much on its size, rapidity of growth, and its location. If the death of the parasite occurs either spontaneouly or as a result of treatment, recovery is the rule. If rupture takes place through the abdominal wall, the result is usually favorable. The next most favorable route of exit is through the intestinal canal, either directly or through the bile duct. If rupture takes place into the pleural or peritoneal cavity, the prognosis is very grave; sudden death from shock or the development of a rapidly fatal acute inflammation generally follows. Recovery after rupture into the hepatic veins, vena cava, or pericardium cannot be looked for. When cyst contents reach the right side of the heart by perforation of the hepatic veins or vena cava, there follow thrombosis of the branches of the pulmonary artery and sudden death by fatal syncope. The same is the result when the pericardium is perforated.

The prognosis in a case when a living hydatid has been diagnosed

should be considered of sufficient import to induce one to adopt measures for its destruction.

Prophylaxis.—The prevention of hydatid disease is worthy of quite as much consideration as the curative treatment proper, and it is true that if proper measures were carried out to guard against the ingestion of the eggs or proglottides of the tænia echinococcus, we would soon cease to see the disease in man. It is also true that if all sources of infection by means of which the scolices reach the stomach of the dog were cut off, the adult tænia would soon become extinct in the intestine of this animal. If man were the only host of the cystic worm, dogs would soon cease to suffer from the presence of the tænia echinococcus, and as a consequence, the supply of eggs and proglottides being cut off, man would no longer be a victim of hydatid disease. However, sheep, pigs, and some other animals have been shown to be affected by the disease; therefore it is very essential that dogs should not be allowed to eat diseased meat and offal found in slaughter-houses. All meat should be inspected and thoroughly cooked before being consumed. Heat destroys the vitality of both scolices and ova. Vegetables which are to be eaten raw should be cleaned and all possibility of the ova being ingested by man in this way excluded.

Treatment.—Medicinal treatment of hydatid cysts is not now thought to be of any use. Iodide of potassium in large doses and chloride of sodium were thought to have the property of causing the death of the echinococcus when given internally. Laennec claimed to have had good results from the local application of salt stupes over the region of the liver, in the belief that a certain amount of the salt reached the interior of the cyst. When we take into consideration the fact that spontaneous death of the cyst often occurs, we can scarcely infer that any drug or application which has been used has brought about the happy result. Mercury and turpentine have both had their advocates.

Surgical Treatment.—The treatment of hydatid tumors belongs to surgery. When a hydatid is large enough to be detected and seems to be growing an operation should be performed. The operations which may be resorted to are the following: (1) simple acupuncture, (2) acupuncture with electrolysis, (3) aspiration, (4) free incision and drainage, or hepatotomy.

The results of acupuncture, either with or without electrolysis, are somewhat uncertain. The operation with electrolysis has no advantage over that without. Its advocates at one time thought that decomposition of the saline fluid in the sac followed, and consequently death of the parasite. When this occurs in these cases it is probably due to the fact that some of the fluid has escaped from the tumor. In simple hydatids, where suppuration has not taken place, this operation is comparatively free from danger when proper antiseptic measures are carried out. Not so, however, where there is already suppuration, and in these cases it should be carefully avoided, because of the probability of some of the pus escaping into the peritoneal cavity. Suppuration may even follow the operation, and then incision and drainage must be resorted to.

When there is a considerable portion of the cyst on the exterior of the liver substance the fluid may be withdrawn by aspiration without much danger, but not where the tumor is very deeply seated. There

is then danger of hemorrhage. This accident may also occur if forcible aspiration is resorted to after the fluid has been withdrawn. The operation should be performed gently, and the process discontinued as soon as the fluid ceases to flow or becomes scanty.

After removal the fluid may return and the tumor attain its former size or even become larger. This is not on indication for repeating the operation unless there is no danger of suppuration and some months or a year has elapsed. This is not, in reality, hydatid fluid, but differs from it in containing albumin, and is really serous effusion, which generally disappears in time if suppuration does not set in. It is probable that the three operations already mentioned all act in the same way, causing death of the parasite by the escape of some of the fluid, and that should be chosen which is least likely to be followed by suppuration. This is a question not settled. Fagge refers to a series of 10 cases treated by acupuncture, not one of which suppurated.

Free incision is the most radical measure at our command, and should be adopted in all cases where there is suppuration, great care being taken that the cyst does not become infected by the introduction of pyogenic organisms. A. H. Ferguson, formerly of Winnipeg, now of Chicago, reports[1] 27 cases in all operated upon by himself by aspiration and incision, and refers to 20 cases in the practice of other medical men of Winnipeg. Invariably the disease occurred in Icelanders. In simple hydatids without suppuration he aspirated, and where there was suppuration he made a free incision, evacuated, and drained.

In multilocular cysts the treatment must necessarily be symptomatic and palliative.

Cysticercus Cellulosæ.

The cysticercus cellulosæ is rarely found in the liver, and its presence cannot be diagnosed during life. It has been known to give rise to abscess.

Psorospermia.

These parasites, which are so frequently present in the liver of rabbits, are very rarely found in man. Hiller in *Von Ziemssen's Encyclopædia* mentions their having been found in 3 cases. In 1, reported by Gubler,[2] they were discovered in the liver of a man who died at the age of forty-five years. Globular tumors existed in the substance of the organ, which were found to contain psorospermia. In another case, reported by Leuckhart, Dressler of Prague found similar small tumors which also contained psorosperms.

Pentastoma Denticulata.

The presence of these parasites in the liver was demonstrated by Zenker.[3] According to Müller's statistics of Zenker's post-mortem examinations in 3694 cases, the pentastomum was not found in one of the 631 cases under twenty years of age, but it was found in 5.16 per

[1] *Northwestern Lancet*, Feb. 1, 1893. [2] *Mém. de la Soc. de Biologie*, 1859.
[3] *Zeitschrift f. Nationelle Med.*, p. 212, 1854.

cent. of those over twenty. It occurred less frequently in the female than in the male. It exists usually near the surface of the liver "in a roundish nodule" the size of a pin's head, which is made up of connective tissue containing a yellow body, generally calcified. When the lime salts are dissolved in an acid "we find the four large claw-shaped feet with their supporting apparatus, as well as fragments of skin which are as clear as glass. The skin is studded with regular rows of fine spines alternating with rows of double contoured stigmata" (Heller).

The adult animal, the *pentastomum tænioides*, is most frequently found in the nasal cavities of the dog.

There are no clinical reports of cases. It is probable, however, that under some circumstances very severe symptoms may arise, especially when a large number of parasites invade the liver at one time.

Distoma Hepaticum and Distoma Lanceolatum (Liver Flukes).

The distomata are yellowish white, flattened worms from 8 to 14 lines in length, which exist principally in the biliary passages of sheep. They have been found in the human subject in a few instances, both in the liver and in the intestinal canal. Harley mentions a case reported by Humble and Lusk.[1] It terminated fatally, and six distomata were found in the hepatic ducts. Cases have also been reported by Aschoff.[2] Lodero of Naples has recorded some cases, and recently a report on distomata in Japan has been made.[3] The ova are taken into the stomach in drinking water or with unwashed green vegetables in the raw state, such as lettuce, cress, etc. The distomum hepaticum, the larger of the two, passes through the common bile duct into the gall bladder, while the lanceolatum, the smaller, enters the outer hepatic ducts and may there multiply.

The SYMPTOMS produced are indefinite, often those of cholangitis or catarrhal jaundice, and a DIAGNOSIS can only be made when they are found in the vomited matter or in the fecal discharges. In some cases the parasites have been found in the contents of a distended gall bladder.

In sheep the distomum causes a condition known as the rot, marked by catarrh of the biliary passages, degeneration and atrophy of the hepatic tissue, occasionally jaundice and subsequent anæmia.

Ascarides.

Tuni[4] reports a case in which ascarides were found in the substance of the liver. They had entered through the biliary ducts.

Actinomycosis.

Bugidi reported a case of actinomycosis in which the primary seat of the disease was apparently in the liver, and the parasites became disseminated through the lungs, giving rise to symptoms resembling those of tuberculosis. In the Japanese cases the liver was found en-

[1] *British Medical Journal.*

[2] "Ein Fall von Distomum Lanceolatum in der Menschlichen Leber," *Archiv f. Path. Anat.*, Berlin, 1892, 493.

[3] *Tokio Medical Journal* (1893).

[4] *Revista Clinica*, Naples, 1890.

larged, the connective tissue increased, and atrophy of the hepatic cells. The bile ducts were dilated.

The principal SYMPTOM described was a feeling of pressure in the epigastrium, with not much pain or general disturbance.

Moser [1] reported a case of actinomycosis in which the liver was studded with innumerable miliary abscesses, together with some of larger dimensions. Fistulous tracts also existed in different parts of the organ. The interstitial tissue was much increased—a secondary cirrhosis. On microscopical examination the characteristic manifestation was the presence of a parasite made up of filaments radiating from a common centre. The pus when examined fresh presented threads and micrococci which were frequently aggregated in masses.

Bacillus Aerogenus Capsulatus.

In a case of typhoid fever reported by Howard and mentioned by Prof. Welch in the *Journal of Experimental Medicine* [2] the liver was invaded by the bacillus aërogenus capsulatus (gas bacillus) through the biliary passages. The patient died in the second week. The gall bladder and bile ducts contained a large amount of gas, and the surrounding tissue was quite emphysematous. Extensive necrosis of the liver cells was noticed on microscopical examination. In other cases reported the same organism was found in the liver, but in none were the lesions so marked as in that just noted.

CARCINOMA OF THE LIVER.

FREQUENCY.—Carcinoma of the liver may be classed among the more common chronic diseases of the internal organs. In the Vienna Hospital 1 case of hepatic cancer occurred in every 322 cases of internal disease; in the Zurich clinic 1 case was found in every 201, and in the Göttingen clinic 1 in every 147. In the reports of the post-mortem examinations in Virchow's Institute, as given by Riesenfeld, there were 69 in 2601 sections, (2.65 per cent.), and, according to Leichtenstern, in 6019 sections 174 were cases of hepatic cancer (2.87 per cent.). The relative frequency of cancer of the liver in the female compared with that of the same disease in other organs is given by Eichhorst, who places the latter in the following order: Uterus, stomach, breast, liver.

ETIOLOGY.—In the great majority of cases of cancer of the liver the disease is secondary to growths in other parts of the body—in the uterus, the gastro-intestinal tract, the vertebral column, or in the os innominatum. In the gastro-intestinal tract the more common situations are the pylorus, the cæcum, the sigmoid flexure, and the lower part of the rectum.

Age.—Carcinoma of the liver is a disease of late adult life, occurring most frequently between the ages of forty and sixty. Leichtenstern has given the ages in 472 cases as follows: between twenty and thirty, 7.8 per cent.; between thirty and forty, 12.9 per cent.; between forty

[1] *N. Y. Medical Journal*, Aug., 1894. [2] Vol. i. p. 44.

and sixty, 53.1 per cent.; between sixty and seventy, 19.3 per cent.; and over seventy, 6.9 per cent.[1] Some remarkable exceptions to this general rule have been recorded from time to time. Siebold reported 1 case of carcinoma in a newly-born child, and Gee a case in a child four months old. Farre has reported 3 cases in children, 1 child being three months old, and the other 2 of two and a half years of age.[2] Kottman has reported 1 case in a girl nine years of age, and Roberts 1 in a girl aged twelve years.[3]

Sex.—Hepatic cancer is more frequent in the female sex, probably because it is so often secondary to cancer of the uterus, ovaries, and mammary glands. When such secondary cases are eliminated, it is found that cancer of the liver does not occur oftener in women than in men. Frerichs was of the opinion that sex did not exert any influence. In 91 cases recorded by him 45 were males and 46 females.

Climate.—Although the more acute diseases of the liver, congestion and abscess, are common in tropical countries, cancer is less frequent. Sachs explains this on the theory that in warm climates the greater activity of the liver makes it an unfavorable soil for the growth of cancer. It is rarely met with in India. Webb makes the following statement, quoted in *Von Ziemssen's Cyclopædia:* "I have never seen a single instance of cancerous deposition in the liver in this country (India), not even in cases where the disease has been well manifested in the uterus, stomach, and intestines."

Traumatism.—Injury to the liver from external violence has been followed by cancer in a number of reported cases. In one the disease followed in four weeks after the injury, and death occurred in fourteen months.

Biliary calculi have been so often found in cases of cancer of the liver that they have been considered by many as one of the causes. It seems quite probable that the irritation due to the presence of gall stones might predispose to the development of carcinoma. In this connection it must not be forgotten that carcinoma may be the primary and gall stones the secondary condition. Musser concluded that biliary calculi are a possible exciting cause of primary carcinoma of the gall bladder in persons predisposed to that disease. In such cases the carcinoma of the liver is secondary to that of the gall bladder and biliary passages.

Heredity is as strong an etiological factor in hepatic cancer as in carcinoma generally. Harley is of the opinion that hereditary tendency is one of the most important causes, and Bartholow gives heredity as the most important factor; whereas Leichtenstern thought that the hereditary element played a very subordinate part. In 12 cases in the Tübingen clinic heredity was clearly traced in only 2 cases. Hess reported 25 cases in the Zurich clinic, and heredity has been proven in only 1. As Leichtenstern remarks, statistics must be based on the statements of the patients, and these are not always reliable. It would seem probable that hereditary tendency exists in a larger proportion of cases than the above statistics would indicate.

Indulgence in alcoholic beverages and malaria have been regarded as causes of hepatic cancer.

[1] *Canstatt's Jahresbericht*, 1854, iv. S. 319.
[2] *Correspondenzbl. d. Schweiz. Aerzte*, 1872, No. 21.
[3] *Lancet*, Jan., 1867.

Pathological Anatomy.—The relative proportion of primary to secondary carcinomata has been variously estimated. The number of cases of primary disease was formerly thought to be much greater than at present. As post-mortem examinations are made with more thoroughness, the seat of the disease is more frequently found outside of the liver. One authority gives the proportion as 1 to 8, but Leube states that the proportion is at least 1 to 40 in favor of secondary growths. Hauseman[1] has analyzed the cases recorded at the Berlin Pathological Institute between the years 1880 and 1889, and found that out of 258 cases the disease was primary in only 6, and 2 of these were doubtful.

The primary carcinomata are observed in three different forms:

(1) The large solitary tumor, massive cancer;

(2) Nodular or circumscribed cancerous masses, varying in number and size, scattered throughout the liver;

(3) Diffuse carcinomata, in which the cancerous structure exists in Glisson's capsule, producing a condition not unlike cirrhosis.

The first and third forms are nearly always of a primary character, and occasionally the nodular or circumscribed variety is also of primary origin. In the latter case the various nodes may grow simultaneously or there exists a primary node from which the others spring. A case of the diffuse form secondary to cancer of the peritoneum has been described by Von Schüppel. The secondary growths nearly always exist as circumscribed masses varying in size and shape.

(1) The massive or solitary tumor is usually of a spherical form, and arises in the deeper portions of the liver, nearly always in the right lobe, and grows toward the periphery, often setting up a perihepatic inflammation and spreading by metastasis to the surrounding organs. The cut surface presents a dirty white color and more or less softening if the tumor is large. A thick creamy substance may be scraped from the surface, and upon closer examination broad fibrous bands of varied thickness may be seen passing in different directions. The boundary line between the carcinoma and liver structure is in some places sharply defined, and the lobules, of a dark brown color, show evidences of pressure and displacement. In the other localities the liver substance in the immediate neighborhood resembles to some extent, to the naked eye at least, the cancerous structure. Small secondary nodules are also found near the margin of the tumor, as well as small hemorrhages and patches of softening. The neighboring veins are partially or completely closed by pressure, and cancerous thrombi may appear both in the portal and hepatic veins, especially in the latter.

The growth is nourished by blood from the hepatic artery, which is more or less increased in size. Pressure on the bile ducts may produce a partial obstruction or result in a catarrhal cholangitis. In either case jaundice of a more or less intense character follows. As the tumor increases in size portions of the centre undergo necrosis, forming a soft cheesy substance which can be easily scraped off. Hemorrhage often takes place into the substance of the growth, and fatty degeneration and destruction of the cells throughout the mass will give the cut surface a greasy feel. Metastatic growths from primary carcinoma of the liver are not frequent, but the glands in the portal fissure may be

[1] *Berliner klinische Wochenschrift*, April, 1890.

enlarged. Upon microscopical examination the tumor is found to be of an epitheliomatous character. The cells exist in spaces formed by fibrous bands, which are of greater or less thickness and density. In most cases the cellular portion is well developed, the spaces are large and round, and the fibrous structure is rich in bloodvessels. The cells vary in shape and size, being often small and more or less cylindrical. There is, as a rule, no uniform arrangement, but occasionally a more or less distinct glandular structure is noticed. The cancer cells originate partly from the hepatic cells and partly from the epithelial lining of the bile ducts.

(2) The nodular or multiple circumscribed form is nearly always of secondary character. The cancer masses vary in number, shape, and volume. They are generally round or oval, and range in size from that of a pea to that of an orange; some reach the size of a child's head. The cut surface is of a grayish white or yellowish white color, and is uniformly hard if the nodule is of recent growth. The larger and older masses may show signs of degeneration and softening in the centre. The nodules which exist near the surface of the liver may become so prominent that they can be easily felt through the abdominal walls. In this situation, owing to internal softening, an umbilication may result which at times can be felt through the walls of the abdomen. The more superficial nodules undergo degeneration more quickly because they are farther removed from the centre of nutrition.

The consistence and structure of the nodules depend largely upon the character of the primary growth. If the latter is a scirrhus, the nodules will be hard and resisting; if encephaloid, they will be softer and contain more fluid. As a rule, cancer nodules in the liver are of moderately firm consistence, and more or less semi-fluid matter can be scraped from the cut surface. In the early stage of the disease the liver may not be much enlarged, but if the secondary deposit takes place before the vital powers are much exhausted, the organ may attain an enormous size. It is generally more or less bound down by adhesions to the the surrounding parts, and may be attached to the stomach or duodenum by the primary growth.

Signs of pressure may or may not be present, depending on the size and number of the cancerous masses. The hepatic cells nearest the growth are often flattened and found undergoing more or less degeneration. When a portion of liver substance is subjected to pressure between two or three nodules, the hepatic cells undergo atrophy and destruction. In some cases the individual cells are surrounded by cancerous growth, and are thus destroyed. Sometimes pressure on the bile ducts may result in biliary obstruction.

The branches of both portal and hepatic veins may undergo pressure and obliteration. Thrombi are formed which adhere to the walls, and which, in the hepatic vein, may extend into the inferior vena cava. This condition, according to Orth, may give rise to cyanotic hardening of many of the cancerous nodules. The lymphatic glands in the fissure of the liver sometimes form large tumors, which by pressure cause obstruction in the veins and ducts. In some of the nodules degeneration and absorption may be followed by a growth of connective tissue, forming the so-called cancer cicatrix. Calcification has been rarely

found. Sometimes, owing to the invasion of pathogenic germs, suppuration takes place in the nodules. When the masses are richly supplied with blood they present a bright red color, and hemorrhages may occur in their substance. When the nodules are situated near the surface blood may be extravasated into the peritoneal cavity.

Colloid cancer exists as a secondary, but never as a primary, growth in the liver. It grows by metastasis or by simple extension from the peritoneum. In such cases the nodules differ from those already described only in the fact that they contain colloid material. When the disease in the liver is directly continuous with that of the peritoneum, the colloid nature of the tumor is more marked. The structure of the nodules depends to a large extent on the nature of the primary growth. A large part is formed by the connective tissue in the trabeculæ. The alveoli vary in shape and size, the shape depending often on the direction in which the section is made.

The form and size of the cells depend to some extent on the surrounding fibrous structure and on the amount of pressure to which they are subjected. They are always of the epithelial type, and are much more frequently cylindrical than squamous. When the growth is secondary to one in the stomach or intestine, the glandular structure may be perfectly shown.

(3) The diffuse or cirrhotic form (cirrhosis carcinomatosa of Perls) was described by Kelsch and Kiener in 1881, and afterward by Hanot and Gilbert,[1] who first classified it as a third form of hepatic carcinoma. On this continent cases have been reported by Adami of Montreal and Fussel[2] of Philadelphia. The writer is indebted to Dr. Fussel's paper for many features of the following description: The liver is not much increased in size, is hard, and presents a surface more or less roughened. The superficial nodules may be cancerous or may be the ordinary elevations of cirrhosis. The capsule is thick and adherent, and the cut surface presents a whitish or slightly reddish connective tissue in which nodules are found, and from the surface of the latter cancerous juice can be expressed. These nodules are very numerous, and vary in size from that of a pin's head to that of a hazelnut or are even as large as an orange. The hepatic tissue, surrounded by fibrous structure, may be very much diminished, and in some situations may exhibit a direct transformation of hepatic into cancer cells. In that portion of the parenchyma in the immediate neighborhood of the nodules cancer cells may be seen pressing into the liver capillaries. The nodules are found to be of epitheliomatous structure, and the larger ones show more or less degeneration.

Kelsch and Kiener give the following description of the minute structure in one of their cases: "There are three kinds of alterations seen—viz. (1) The depressed and finely granular portions, which present all the characteristics of cirrhosis. The connective tissue is opaline or reddened, very vascular, and contains circumscribed granulations varying in size from the head of a pin to that of a small pea. These granulations are of a grayish ochre color, mostly firm, and can be scraped out with the back of a knife. (2) The tumors, of the size of a hazelnut

[1] *Étude sur les Maladies du Foie*, 1888.
[2] *Transactions of the American Association of Physicians*, 1895.

to that of an orange, are softer than the fine granulations, and are generally circumscribed by a zone of hyperæmic connective tissue; others are in a caseous state and can be easily shelled out from their capsule, while still others are of a syrupy consistence."

The larger tumors are aggregations of smaller nodules, separated by embryonal connective tissue and surrounded by fibrous bands. Secondary invasions occur in this as well as in other primary carcinomata. The lungs are the organs most frequently involved. Ascites is usually present, and the spleen is enlarged. The carcinoma is shown by the microscope to be of epithelial form, and the connective changes resemble those of a true cirrhosis. It is probable that the cirrhotic process follows or accompanies the cancer formation, although in some cases Hanot and Gilbert were of the opinion that the cirrhosis and adenoma were of simultaneous growth and that both were caused by the same irritant.

Primary carcinoma of the liver must necessarily arise from cells of the epithelial type, either from hepatic cells, cubical epithelium of the biliary radicals, or from the columnar cell of the larger bile ducts.[1] Kanthack and Lloyd have recently reported 3 cases of primary carcinoma, in 1 of which they were able to make out clearly the origin of the growth in the epithelium of the biliary radicles and of the smaller bile ducts.

Von Schüppel mentions a diffuse infiltration of the liver secondary to cancer of the stomach and peritoneum. This seems to have been of a character different from that of those just described.

The writer has recently had under observation a case in a female who had suffered for years from lupus erythematosus. A diagnosis of carcinoma was made on account of a nodule which projected from the anterior border. At the post-mortem examination the cirrhotic appearance of the liver was so marked that it was only after microscopical examination the cancerous nature of the disease was positively demonstrated.

Symptoms.—Cancer of the liver may exist either in the primary or secondary form, without the presence of symptoms sufficient to make a positive diagnosis. In many cases also the symptoms of the primary disease in the stomach, intestine, or uterus are so prominent that the physician may altogether overlook those connected with the secondary condition in the liver, and at the post-mortem examination the presence of cancerous nodules may be the first intimation of involvement of that organ. Leichtenstern makes the statement "that secondary cancer of the liver in very numerous instances runs its course without symptoms, and clinically cannot be diagnosticated." In such cases the liver is not enlarged, the constitutional symptoms are not marked, and the presence of ascitic fluid or gaseous distention of the abdomen may prevent the physician from obtaining an accurate knowledge of the condition of the liver by palpation. On the other hand, the hepatic changes may be so marked as to altogether overshadow those connected with the primary seat of the disease. Two years ago the writer was called to see a case of great enlargement of the liver with jaundice. According to the history, the patient had been in poor health for about four months, and the hepatic disease commenced about six weeks before the visit. The liver

[1] *St. Barth. Hospital Reports*, 1896.

was enormously enlarged and the patient was in a semi-comatose state, the result of cholæmia. Upon examination of the rectum a cancerous mass was found which had not given rise to any special symptoms and which was no doubt the primary disease.

The onset of hepatic carcinoma is often very insidious. The patient may complain only of a feeling of weight and enlargement in the abdomen, and when the physician is first consulted he may find the lower margin of the liver nearly as far down as the umbilicus.

Physical Examination.—The liver is usually enlarged, but this is a general rule to which there are many exceptions. According to Frerichs, there is no increase in volume in about one fourth of the cases. The extent of the enlargement may vary from a little above normal to a size sufficient to fill the upper part of the abdomen. A case has been described by Roberts [1] of a girl in whom the liver weighed ten pounds. It had almost completely compressed the right lung, and had exerted sufficient pressure on the right subclavian artery to weaken the pulse at the wrist. The weight of the liver in one of Frerichs' cases was twenty pounds, and Key recorded one in which the weight reached twenty-five pounds. The liver attains its largest size in cases of primary disease or when in the secondary cases the primary condition has not interfered much with the general nutrition of the patient. When the liver is attacked after extensive general emaciation has taken place it may not increase in volume. It attains a greater size in young than in old people. Atrophy has occasionally been noticed. Fagge has reported a case of scirrhus of the liver in which the weight was thirty-six and a half ounces, and Harvey reported another weighing twenty ounces.

An enlarged liver may seem to become smaller from the increase of ascitic fluid or from the presence of gas in the gastro-intestinal tract. When there is even a moderate amount of ascitic fluid it may be possible to palpate the liver only by sudden pressure of the fingers. If the abdomen is much distended and the liver slightly enlarged, the physician may not be able to obtain any accurate information by physical signs. In a few cases the liver diminishes in size in the later stages. When there is great enlargement the ribs in the lower portion of the right thorax are pressed outward and the circumference of that side is increased. The area of hepatic dulness is increased in both vertical and transverse diameters, and it may change in locality when deep inspirations are made.

The liver may present a smooth upper surface, or nodular elevations may be felt on it as well as on the anterior margin. Occasionally a sinking in or umbilication of the nodules can be distinguished through the abdominal walls. A friction fremitus may be felt on deep inspiration. This is produced partly by the roughened surface and partly by localized perihepatitis. A coarse friction rub due to the same cause is also heard when the ear or stethoscope is applied over the hepatic surface. The liver moves with forced inspiration if it is not firmly attached or too large.

Constitutional Symptoms.—The constitutional symptoms of secondary carcinoma of the liver may be classed as follows:

(1) Symptoms of the primary disease;

[1] *Lancet*, Jan., 1867.

(2) General symptoms of hepatic disturbance;
(3) Conditions resulting from pressure on the bloodvessels and bile-ducts.

(1) Symptoms of the primary disease are present to a greater or less extent in the majority of cases. When the uterus or lower portion of the rectum is affected a positive diagnosis may be made by digital examination. This examination should be made in all cases, even though there be no symptoms pointing to disease in the pelvis. Cases not infrequently occur in which disease of the rectum is overlooked. Carelessness, the absence of system in examination, and the repugnance of patients to a disagreeable procedure often account for this error. When the primary disease occurs in the pylorus the tumor can frequently be palpated, and the presence of dilatation of the stomach with the general symptoms of stenosis may confirm the diagnosis. Carcinoma of the cæcum or the sigmoid flexure may be felt through the walls of the abdomen. In almost all cases the tumor is accompanied by tenderness and pain.

(2) The most prominent earlier symptoms of hepatic disturbance are anorexia, nausea, vomiting, and flatulent distention of the abdomen, while a feeling of great distress is marked in rapidly growing carcinomata. The patient complains of dryness of the tongue and thirst. Constipation is frequently experienced as the result of slow peristaltic action and deficiency of bile. In cases of jaundice the fæces are clay colored and have a most offensive odor. Diarrhœa is sometimes present in the later stages. Emaciation is especially marked in the more chronic cases and may exist in an intense degree. The skin becomes thin, dry, and scaly, and presents a peculiar waxy or greenish yellow color. The ends of the long bones become very prominent, and in the late stages œdema of the legs supervenes.

The peculiar cachexia of cancer was present in 13 of Frerichs' 31 cases.

A patient of Leichtenstern weighed, on entering the hospital, eighty-two pounds, and three weeks afterward the cadaver weighed sixty-four and a half pounds. The patient's weight in health was one hundred and thirteen pounds. The great emaciation may be accounted for by the digestive disturbance, by the absorption of albuminoids rendered necessary for the growth of the cancer, and by the presence of fever. It is also probable that a toxin peculiar to cancer may play an important part.

The temperature is normal or subnormal except in the more acute cases, when it may rise two or three degrees. During the course of the disease fever may be induced by catarrhal affections or by suppurative processes.

The pulse is normal in frequency in the early stages, and becomes rapid, small, and irregular toward the end. When intense jaundice is present the pulse may be abnormally slow, but in the more acute cases it is often rapid throughout. The heart sounds are often clear, loud, and ringing, and occasionally a systolic bruit is present. Owing to thinness of the chest and retraction of the lungs the area of cardiac dulness may be increased, although the heart itself may be diminished in volume. An examination of the blood by the microscope will reveal the condition usually found in anæmia.

The red blood-corpuscles are reduced in number, are paler in color, and present changes both in form and size. The number of leucocytes is increased, and the proportion of hæmoglobin is lessened, being not more than 50 or 60 per cent. of the normal. The author has recently had under observation a case in which the hæmoglobin was diminished to 20 per cent. of the normal. According to Leichtenstern, the amount of hæmoglobin increases toward the end of the disease.

The intellect remains bright in most cases until the very last. Sometimes delirium results from extreme marasmus or from the presence of fever. In some cases the cholæmia produces a semi-comatose condition. The patient is often irritable and much depressed. In a case recently under the writer's care the mind was clear and the patient was hopeful until the last two or three weeks.

Insomnia and pruritus are often very troublesome symptoms, and the latter may be present when there is no jaundice.

Pain in the region of the liver is often acute and lancinating. It radiates toward the right shoulder and to the lumbar region. It may be of a dull character and accompanied by a feeling of distention which is often more distressing than the pain itself. The radiation to the right shoulder may be explained by the close connection which exists between the phrenic and the fourth and fifth cervical nerves. The darting pains throughout the abdomen have been explained by Leichtenstern through the connection between the nerves of the liver and the sympathetic ganglia of the abdomen. The severity of the pain depends on the situation and rapidity of the growth, as well as on the presence of perihepatitis. Budd observed that the pain was not so great when the nodules were deeply seated and grew slowly. When they existed on the surface and grew more rapidly the pain was more severe. Tenderness is also greater when the growth is superficial and rapid. The nodules may show an increase in size almost from day to day in some cases. Occasionally the pain is very severe when the nodules are small and deeply seated. Tenderness is nearly always present in some stage of the disease. It was quite absent in 2 of Frerichs' cases. The respirations are often shallow, and a deep breath is accompanied by pain, the result of perihepatitis. Dyspnœa may be experienced on exertion, due partly to local causes and partly to the weakness and anæmia.

The urine is usually scanty and high colored, and contains a large amount of sediment. Indican is often present in excess, and bile pigment will be found in cases of jaundice. The whole amount of urea excreted is often diminished. In some cases bile pigment is found in the urine when there is no discoloration of the skin. In pigmentary sarcoma melanin is often found in large quantities in the urine. It becomes black on exposure to the air or on the addition of nitric acid. Leucin and tyrosin are not often met with. Casts, the result of irritation of the kidneys from bile pigment, are occasionally found in the urinary sediment.

(3) Symptoms may result from pressure on the bloodvessels and bile ducts. Ascites arises from stenosis of the portal vein or from other causes. It may be a part of general œdema from cardiac weakness or it may result from general peritonitis produced by development of cancerous nodules throughout the cavity. According to Leichtenstern,

ascites was found in 50 per cent. of 254 cases. The pressure of a tumor may cause only partial obstruction of the portal vein, which is not sufficient to cause ascites until toward the end of the disease, when on account of cardiac weakness fluid may be transuded into the abdominal cavity. Two or more causes may exist in the same case. When the portal vein is obstructed the amount of fluid is greater than when the ascites arises from the other causes mentioned. The ascitic fluid, which contains from 1 to 4 per cent. of albumin, may be clear or of a greenish yellow or reddish color. It is nearly always of an inflammatory character, containing shreds of lymph, and this is more particularly the case in some instances when an inflammation spreads over the greater portion of the peritoneum. It may contain pus from rupture of a cancer nodule which has been invaded by pus germs, and blood is found when an extravasation takes place into the peritoneal cavity. Enlargement and prominence of the subcutaneous veins of the abdomen are noticed when an obstruction exists to the flow of blood through the portal system or when from pressure on the inferior vena cava the return of blood to the heart is interfered with.

Jaundice occurs when the cancer produces obstruction of the larger biliary ducts or when catarrhal or suppurative cholangitis is present. It may vary in intensity from a slight subicteric tint to an intense greenish yellow color. The color sometimes resembles that of Addison's disease. Its persistence is a marked diagnostic sign of cancer of the liver. It was absent in 13 of Frerichs' 31 cases. According to Leichtenstern, it occurs in about half of the cases. Jaundice may be caused by calculi in the passages in cases of hepatic cancer.

Course and Duration.—The duration of hepatic cancer varies from a few weeks to one or two years. Bamberger reported a case which lasted eight weeks, and Frerichs one in which death occurred at the end of four weeks. The writer had under observation a physician who in the month of March complained of hepatic disturbance, anorexia, nausea, vomiting, pain, and distress in the hypochondriac region. Soon the symptoms became intensified, and the patient suffered the greatest distress from a feeling of distention and pain in the upper part of the abdomen which prevented him from sleeping or enjoying a moment's rest. The liver increased rapidly in size, and within five weeks after the first appearance of marked symptoms the patient died. At the autopsy a large cancerous liver was found. The examination was not made sufficiently exhaustive to exclude the possibility of primary disease elsewhere, but there were no symptoms of such during life. Acute cases of this character are not rare.

It is quite probable that in some instances the disease may have been in existence for weeks or months before the patient or his friends became aware of the fact. The physician is occasionally surprised to find very great enlargement of the liver in a patient who up to the time of consultation had been able to attend to his ordinary work, and who did not complain of more than a sensation of fulness and weight in the abdomen. In many cases the course of the disease extends over months, and the process of emaciation is slow but steadily progressive. Eichhorst gives as the average duration fifteen to thirty weeks from the first symptom. According to Frerichs, it may last as long as five years.

Death may result from marasmus, from some intercurrent disease, or from jaundice. A purpuric condition occurs in this as in many other severe hepatic affections. General anasarca and pulmonary œdema, the result of cardiac weakness, may be the immediate causes of death. Obstruction or perforation in the intestinal tract may take place and end fatally. Catarrh of the bronchi and inflammation of the lungs are not infrequent intercurrent affections. The symptoms of primary carcinoma are not preceded by any special disturbances in the stomach or bowels. In the massive and nodular forms the symptoms are quite similar to those already given. In the diffuse form the ascites comes on earlier and is more marked; the veins on the abdomen are more prominent, and hemorrhage may take place from the stomach or bowels. The symptoms of this form very much resemble those of interstitial hepatitis, and cases of diffuse carcinoma are sometimes mistaken for those of atrophic and hypertrophic cirrhosis.

Diagnosis.—The differentiation between primary and secondary carcinomata of the liver is often difficult during life, and sometimes not very easy on the post-mortem table. In secondary cancer the early history will reveal symptoms of the primary disease in the stomach and intestine, and when its seat is in the uterus or rectum its presence may be ascertained by digital examination. In some cases of cancer of the stomach and intestine the symptoms are so few and of such little prominence that the secondary involvement of the liver seems to be the only condition present. In all cases of doubt it is necessary to examine the whole body for primary carcinoma, because, although the early seat of the disease may be in the gastro-intestinal system or in the pelvis, it may exist primarily in almost any part of the body—in the gall bladder, pancreas, mediastinum, vertebral column, or peritoneum.

The principal diagnostic features of a primary carcinoma are the early appearance of hepatic symptoms and the absence of signs of disease elsewhere. Primary cancer usually runs a rapid course, and the enlargement is often very great. When the gall bladder is first affected the growth may appear in that region at the commencement of the disease. If the biliary passages are the seat of the primary cancer, obstructive jaundice is one of the earliest and most prominent symptoms. The presence of a multilocular hydatid cyst leads to an enlargement of the liver which may be mistaken for carcinoma. The former may be distinguished by the softness of the nodules, the greater duration of the disease, and the very late appearance of cachexia. Enlargement of the spleen is more frequently found in the hydatid condition. An examination of the fluid withdrawn may aid in the differentiation. The peculiar fremitus found over a large unilocular cyst may be sufficient to decide its character.

Sarcoma of the liver is distinguished in most cases from carcinoma with great difficulty. When sarcomatous tumors exist elsewhere a nodular enlargement of the liver may without much doubt be ascribed to the same disease. The absence of ascites would also favor the diagnosis of sarcoma.

When in some cases the bile ducts are obstructed by calculi an inflammation of the surrounding parts produces a hardened mass which has sometimes been mistaken for carcinoma. Pain, jaundice, and he-

patic enlargement may all be present, and the long duration is often a misleading feature. The history of repeated attacks of biliary colic should put the physician on his guard. The absence of ascites when the jaundice is intense would favor the diagnosis of biliary obstruction. In cases where calculi are known to be present it is sometimes difficult, if not impossible, to exclude carcinoma which may develop as a result of irritation. In chronic fibrous pylephlebitis an induration may exist near the under surface of the liver which may be taken for cancer. A careful examination into the previous history and the absence of cachexia may aid in the diagnosis.

Hepatic and perihepatic abscesses often run a slow subacute course, and may in some respects resemble carcinoma. Jaundice occurs more frequently and is more intense in cancer, while a careful examination into the early history may bring to light other differences.

Amyloid liver is differentiated by its slow progress and by the presence of a previous suppurative, syphilitic, or tubercular condition with accompanying anæmia. Then the surface of the liver is smooth, and enlargement of the spleen as well as albuminuria may exist. When cirrhosis and amyloid disease occur together the surface of the liver may be more or less roughened.

The fatty cirrhotic liver may also present a nodular surface not unlike that of carcinoma, especially the diffuse form. The habits of the patient, the presence of alcoholic dyspepsia, and an early history of hemorrhage from the gastro-intestinal tract point to the probability of cirrhosis. The greater severity of the pain and the presence of metastatic formation, especially in the lungs, would point to diffuse carcinoma. Hypertrophic cirrhosis is differentiated by the exacerbations of fever accompanied by jaundice which are peculiar to this condition. The good appetite and maintenance of the general nutrition is in marked contrast to the anorexia and great emaciation of carcinoma. Syphilitic enlargement, especially the sclero-gummatous form, may give rise to some difficulties. Pain, tenderness, jaundice, and ascites may all be present in syphilis as well as in carcinoma. A diagnosis of syphilis may be made from the previous history and from the presence of syphilitic lesions elsewhere. The administration of iodide of potassium, which exerts such a marked influence on this condition, will help to clear up the difficulty. Syphilis, as a rule, occurs at an earlier age.

Carcinomata of neighboring parts, such as the pylorus, pancreas, mesentery, colon, and kidney, may be mistaken for those of hepatic origin. The diagnosis of pyloric carcinoma when the tumor is not attached may be made by careful palpation of the liver margin and the mobility of the growth. The presence of gastrectasis and of gurgling through the indurated mass would point to pyloric disease. When the tumor is attached the difficulty of diagnosis is increased. A careful examination into the previous history may reveal the early presence of gastric symptoms.

Tumor of the right kidney, if it be not large, may be differentiated without difficulty by bimanual palpation, especially if the abdominal walls are thin. When the growth is extensive it may be distinguished by ascertaining the relative position of the ascending colon, which should pass obliquely over it, and when empty give a tympanitic note on per-

cussion. The examination will be made more exact if the colon is emptied by a purgative, filled with water, and then with air. It may also be possible to palpate the liver margin. The absence of movement on respiration is not to be relied upon, as in cases of great enlargement and adhesions the liver is more or less immovable. A careful examination of the urine will often give valuable information. Tumors of the colon, especially at the junction of the ascending with the transverse portion, are usually more readily diagnosed. Care should be taken by a thorough cleaning out of the bowels to exclude the possibility of the presence of hardened fecal matter. Growths in this situation are often movable and can be separated from the liver. In some cases, however, they are attached, and hepatic symptoms may also be present. A careful study of the history will then decide as to the origin of the tumor.

A displaced liver, especially that produced by tight lacing, has been mistaken for carcinoma. The smoothness of the surface, the absence of cachexia and of localized pain and tenderness, should make the diagnosis easy. Lander Brunton has recently reported a case in which a carcinoma of the left lobe of the liver very much resembled an aneurysm. Pulsation and bruit were present, but the tumor moved up and down with respiration.

The writer had under observation about a year ago a case in which an enormous tumor of the abdomen was thought to be an hepatic carcinoma. On post-mortem examination a very large round sarcoma was found which originated near the spine, was firmly attached to the under surface of the liver, and pressed it upward. The liver itself was not much enlarged.

PROGNOSIS.—Notwithstanding the fact that degeneration and cicatrization often take place in cancerous nodules, the disease is absolutely incurable. Those who were of opinion that cancer of the liver was sometimes curable probably mistook syphilis for carcinoma.

The TREATMENT is altogether of a palliative character. The bowels may be regulated by mild cathartics, such as salines, the compound rhubarb pill, the compound licorice powder, or by enemata. Drastic purgatives should be avoided. The severity of the pain will often necessitate the use of sedatives. Morphine given hypodermically will be found the most effective. Remedies are often required for the relief of other distressing symptoms. For the vomiting, bismuth, hydrocyanic acid, and creasote may be given, and the application of a sinapism over the epigastrium will often be of service. For the abdominal distention antiseptics, such as salol, creasote, and carbolic acid, may be necessary. Murchison recommends an aqueous solution of carbolic acid with chloric ether in peppermint water. When there is biliary obstruction ox-gall pills or, as Frerichs recommends, choleate of soda may be given to aid the intestinal digestion.

The attempt to cure hepatic cancer by iodine, mercury, or arsenic should be avoided, as these remedies often weaken the patient and render his condition less tolerable.

A mixed diet should be recommended, avoiding those articles which are irritating to the liver, such as spirits, salted meats, fatty matter, or highly seasoned food.

The skin should be kept in good condition by the use of sponge baths and massage.

Harley, under the head of general régime, makes the following recommendation: Take amusement without excitement, exercise without fatigue, and nutrition without stimulation.

DISEASES OF THE GALL BLADDER AND DUCTS.

By J. E. GRAHAM, M. D.

CARCINOMA OF THE GALL BLADDER AND BILIARY PASSAGES.

Frequency.—The comparatively frequent occurrence of cancer of the gall bladder and bile ducts has received a good deal of attention both on this continent and in Europe. In an exhaustive paper by Musser[1] a collection of 159 cases is given. In 129 cases of new growths in the internal organs tabulated by Norman Moore,[2] 10 were cases of primary carcinoma of the gall bladder and large bile ducts.

Etiology.—*Sex.*—Von Schüppel was of the opinion that the disease was of almost equal frequency in both sexes, but it has since been fairly well established that carcinoma of the gall bladder is more common among women. The biliary passages are affected equally in both sexes.

Age.—In Musser's collection[3] of 100 cases of carcinoma of the gall bladder, 19 occurred between forty and fifty; 27 between fifty and sixty; and 17 between sixty and seventy. According to the same authority, the average age in 15 cases of cancer of the bile passages was about fifty-six years. Moxon has reported a case of villous carcinoma of the gall bladder in a girl four years of age, and Durand a case at eighty-one years.

Calculi.—Gall stones were found in 63 of Musser's 100 cases of gall-bladder disease, and were noted absent in only 3 cases. It is therefore probable that biliary calculi exist in a much larger proportion than 69 per cent. of cases. The gall bladder contained calculi in 7 of the 18 cases of cancer of the biliary passages. The frequent association of calculi with cancer of the gall bladder and passages has therefore been amply demonstrated. Much difference of opinion has been uttered as to which is the primary condition. Klebs, Von Schüppel, Frerichs, and Murchison believed that the calculi existed previous to the development of carcinoma, and were in many cases the cause. On the other hand, some have thought that stasis and decomposition of the bile in the gall bladder, the result of cancer, predisposed to the formation of calculi. Those who have opposed the theory that gall stones by irritation may produce cancer give as proof the fact that calculi are so often found in the kidney and renal passages without the subsequent occurrence of cancer. As Musser points out, the reason for this may be that the

[1] *Transactions of the Association of American Physicians*, 1889.
[2] *Bradshaw Lecture*, 1889.
[3] *Loc. cit.*

mucous membrane of the gall bladder is much richer in glands than that of the pelvis of the kidney or urinary bladder, and thus, owing to the presence of a large amount of epithelial structure irritation would more likely be followed by carcinoma.

Heredity does not seem to have had any special influence in the causation of cancer in this situation.

Pathological Anatomy.—In 64 of Musser's collection of 100 cases of cancer of the gall bladder the variety was given: 23 encephaloid, 19 scirrhus, 6 colloid, 4 villous, and 12 were recorded as cylindrical-celled epitheliomata. Encephaloid and scirrhus were the varieties most frequently found in the passages. While primary carcinoma of the gall bladder may attain a great size, that of the biliary passages is usually not larger than that of a walnut or hen's egg.

Cancer of the gall bladder may exist as a round or flattened tumor, but it is sometimes more or less nodular and occasionally pointed. The cavity is often filled by the cancerous mass. It is sometimes distended, and may contain grumous semi-fluid matter. Not infrequently biliary calculi are found imbedded near the neck or in the cystic duct. The growth may commence at the neck or the fundus. When the neck is first involved the gall bladder may be dilated or atrophied, and when the fundus is first attacked the walls are much thickened and the cavity smaller, or the cancer may replace the whole cyst. Ulceration of the walls and fistulous openings into the surrounding viscera have been noticed in some cases. The opening takes place more frequently into the colon.

Gall stones are found in the great majority of cases. They are usually of the ordinary variety, and may have been in existence previous to the carcinoma. In only 1 case, that of Ord, a calculus of a peculiar chemical composition was probably formed after the commencement of the carcinoma. The constituents were carbonate and phosphate of lime and altered mucus. It did not contain biliverdin, biliary salts, or cholesterin.

In many cases of primary disease of the gall bladder the ducts become secondarily affected. Obstruction may occur in them either by secondary growth or by continuity. Dilatation is found in some parts and constriction in others, with more or less thickening of the walls. The biliary passages are much oftener the seat of secondary than of primary growth. Primary carcinomata may exist in any part of the bile ducts, but they are most common at the junction of the hepatic with the cystic duct or at the duodenal opening. Obstruction with extreme dilatation of the passages above the point of occlusion is often found. More or less ulceration may also exist.

The carcinoma usually forms a ring around the ducts, and in this way the obstruction is first produced. The inner surface of the ring may be smooth or ulcerated. When the liver is the seat of secondary growth it becomes enlarged, but in the enlargement is often not marked. The obstruction to the flow of bile will, however, result in a greater or less increase in size.

Symptoms.—Pain is present in a large proportion of gall bladder cases—in 15 out of 17 of Villard's cases, in 60 per cent. of Musser's collection. It may be of a dull character or it may be sharp and lancinating. It is usually situated in the right hypochondrium and radiates toward different parts of the abdomen. The pain is often pre-

ceded by a sense of weight, and increases with the progress of the disease. Cancer of the bile ducts is not attended by severe pain. Its absence is distinctly mentioned in some recorded cases. It was present in 12 of Musser's 18 cases, and was one of the earliest symptoms observed. Although present in so many cases, it was not so severe as to produce much disturbance except in a very few.

Jaundice is not commonly present in the earliest stages of cancer of the gall bladder, but is developed later on in a large proportion of cases. It is due to continuation of the growth into the walls of the ducts, to the pressure of enlarged glands in the portal fissure, to catarrhal or suppurative cholangitis, and in a few cases to occlusion of the common bile duct by calculi.

In cancer of the ducts jaundice is an early and almost constant symptom, occurring in 17 out of 18 cases. It is usually of a most intense character, and is often accompanied by delirium, coma, and the hemorrhages which so frequently occur when this condition becomes chronic.

Tumor.—The presence of a growth can be made out in a large proportion of cases of cancer of the gall bladder. It is usually felt in the right hypochondrium, and may be continuous with the liver or be felt an inch or two beneath the lower margin. It is sometimes situated near the umbilicus or in the iliac fossa. The tumor may vary in size; sometimes it is large, round, and elastic, due to distention of the gall bladder, or it may be sharp and more or less pointed, pressing on the abdominal walls. When the gall bladder is distended fluid may be detected by palpation. A tumor was felt in 8 of Musser's cases of cancer of the bile ducts. Such growths are generally described as hard, round, and painless, and are in some cases accompanied by distention of the gall bladder. More or less pain and tenderness is experienced in the majority.

The liver is frequently the seat of secondary growths, and the consequent enlargement can be easily made out during life. Occlusion of the bile ducts will produce those changes in the liver already described under the head of jaundice.

Secondary carcinoma of the liver is relatively more frequent when the primary disease is situated in the biliary passages than when it is in the gall bladder.

Emaciation and cachexia are present as in hepatic cancer. The emaciation is sometimes not marked, as the patient may die from an early complication, and the cachexia may not be observed, owing to the intensity of the jaundice.

Symptoms connected with the intestinal system—anorexia, nausea, and vomiting—are more or less marked. The latter may be due to gastritis or to the presence of a tumor pressing on the duodenum or growing in its walls. In some cases a fistulous opening is formed into the intestinal canal, and a large gall stone with or without hemorrhage may be passed *per anum*. Diarrhœa alternating with constipation is present in a large number of cases.

Ascites, the result of pressure of the primary tumor on the portal vein, sometimes exists to a marked degree. Œdema of the legs and general anasarca are noticed in the later stages.

The temperature is generally normal or subnormal, and when elevated it is due to some complication, such as cholecystitis, cholangitis, peritonitis, or ulceration.

Course and Duration.—The average duration of cancer of the gall bladder is about six months. The shortest duration noted was seven weeks and the longest four years. The course of the disease is progressively downward—a general rule to which there are few exceptions. Death may result from intense jaundice, from peritonitis, perforation, dysentery, or œdema of the lungs. Von Schüppel stated that the average duration of cases of cancer of the biliary passages was from four to six months, although individual cases have been known to live for two or three years. The causes of death are severe jaundice, exhaustion, hemorrhage, and accidental complications, as pneumonia, pericarditis, and œdema of the lungs.

A Case of Primary Carcinoma of the Gall Bladder, with Secondary Involvement of the Liver.—J. J——, æt. 43, shoemaker, admitted to the Toronto General Hospital January 28, 1895. The patient had suffered for years from bilious attacks, induced, he thought, by certain kinds of food, especially pork. These attacks occurred about once a month, but sometimes six months would intervene. They were so severe that recovery did not take place in less than three or four days. The chief symptoms were nausea and the vomiting of a deeply stained material. Three years ago he suffered from an illness which lasted about six weeks and which was diagnosed as congestion of the liver. After about a week of dull pain in the hepatic region he was seized with a violent spasm, which was so sudden and severe that he fell on the floor. This was followed by vomiting and excessive perspiration. In a short time jaundice supervened and the patient remained in bed six weeks, during which time, from the description, he seems to have suffered from an inflammation in and around the liver. This attack was probably one of cholangitis accompanied by biliary colic.

Fig. 31.

Carcinoma of the gall bladder.

The present illness began last August, when he noticed a slight pain and tenderness over the region of the liver, with nausea and a desire to vomit. Thinking that from former experience an emetic might be of service, he took one and vomited freely. He was not relieved, but felt weaker afterward. During the last six or eight weeks he has noticed gradual enlargement of the liver, with the development of nodules on the surface, especially one in the region of the gall bladder. Jaundice occurred early in the illness, but has gradually passed off, and now only a slight tinge is seen in the conjunctiva and skin.

Present Condition.—Patient does not suffer from pain in the stomach

except after eating, when he has also eructation of gas with a sense of weight and distention. The bowels are constipated and the discharges are of a grayish color and more or less sticky. They contain a small amount of fat. The abdomen is distended. The lower part is round and tense, and the upper part prominent. The liver can be distinctly seen pressing the walls of the abdomen forward. Nodules can be felt at various points over the liver surface. A large one was found in the left hypochondrium below the margin of the ribs internal to the nipple line, and another smaller one in the median line midway between the ensiform cartilage and the umbilicus. A very distinct hard and prominent nodule was felt like a knuckle pressing the skin forward, situated a little below the margin of the liver in the upper portion of the right iliac region. This was noticed quite early in the disease before any of the others. We were somewhat in doubt whether it arose from the liver or was simply attached to it. The tumor, as will be seen, sprung from the gall bladder.

Liver considerably enlarged. The lower border begins on the left side at the top of the tenth rib, passes across the median line an inch above the umbilicus, and then obliquely downward below the margin of the ribs, where it cannot be further distinguished on account of the tension of the walls of the abdomen. The spleen could not be felt. A marked friction fremitus was noticed over different portions of the liver when deep respirations were made.

Percussion.—The upper limit of liver dulness commences at the sternum, at the lower border of the fourth rib, follows it to the nipple line, then to sixth rib in mid-axillary and seventh in posterior axillary line, then horizontally across to the spine, touching the ninth rib. Lower border on left side is the same as found on palpation up to the median line; then it takes an oblique course downward and backward, passing about an inch above the crest of the ilium.

Auscultation.—A distinct rough, grating friction sound could be heard over some of the nodules on deep inspiration.

Circulatory System.—Heart sounds weak in all the areas; first sound at apex especially weak.

Pulse full, not easily compressible. Some arterio-sclerosis.

Nothing abnormal in the respiratory system.

Nervous System.—Pain extreme over the liver at a spot where a nodule is rapidly growing. Pruritus ani exists and is quite severe.

Urinary System.—Heavy deposit of pink urates occupies two fifths of the volume of urine when it remained some time in a precipitating glass. Above the sediment the urine is of a heavy opaque yellow color. Odor very disagreeable; specific gravity, 1028; reaction, acid; color, after heating and disappearance of sediment, is dark yellow.

Chlorides, sulphates, and phosphates normal.

Albumin, sugar, and bile absent.

Amorphous urates found on microscopical examination.

Blood Examination.—Corpuscles, 4,140,000; hæmoglobin, not estimated.

The course of the disease can be briefly given. The patient, when he came in, was suffering from severe pain and more or less fever as the result of the growth of a nodule, which could be plainly felt as a

protrusion about the size of a small orange to the left of the median line. Friction sounds could be distinctly felt in the same situation.

In about a week's time the pain and tenderness to a great extent disappeared and the patient's condition improved. He remained in this state for two or three weeks, when he again complained of pain along the lower margin of the liver a little to the right of the median line, and in a few days another nodule developed, accompanied by the local and general symptoms, as in the one already described. After this the patient became rapidly weaker and more emaciated.

Bile pigment was not found in the urine at any time during the illness. Toward the end the discoloration of the skin became more marked.

During the week before death he remained the greater part of the time in a sort of stupor, complaining of intense pain rather than weakness.

Owing to the great enlargement of the left lobe of the liver and the great abdominal tension the diaphragm was pushed upward, interfering with the breathing action and producing much distress on this account.

Patient was first given salol as a hepatic stimulant and disinfectant. Salicylate of soda was afterward given. Then, thinking of the possibility of a sclero-gummatous condition being present, patient was put on a course of potassium iodide. The drug did not cause any lessening of the nodules, but patient expressed himself as feeling better after the administration of the medicine. He took the iodide about three weeks.

The liver increased in size rapidly during patient's stay in the hospital. This was shown rather by the pushing up of the diaphragm and by the increased tension of the abdominal walls than by the lowering of the lower margin of the organ. During the last few weeks a distinct depression or umbilication could be distinguished over one of the large nodules.

Post-mortem Examination.—Body much emaciated; dark discoloration of skin. On opening the abdomen, which was much distended, a considerable quantity of ascitic fluid, not very deeply stained, was found.

The liver weighed fourteen pounds. It filled the whole of the upper part of the abdominal cavity, and presented a rough, uneven surface, owing to the presence of large nodules. The cut surface presented large cancerous masses, with a liver substance separating them in places, while in other portions the cancerous masses were separated by fibrous structure. The nodule, which during life was felt below the liver in the upper part of the right iliac region, and which was first noticed by patient, the post-mortem revealed to be a cancerous mass which had originated in the gall bladder. The greater portion of the latter was destroyed, leaving only a small cavity near the cystic duct, which was occupied by two large calculi, each about the size of a small hazelnut. The portion of the cancer which sprung from the walls of the gall bladder seemed to be of a villous character. The common bile duct was permeable, but the calibre was much diminished. Some recent fibrous adhesions existed between the surface of the nodules and the parietal peritoneum. Stomach somewhat dilated; pylorus healthy. No evidences of carcinoma were found in any other part of the body.

This case presented many points of interest:

(1) The presence of friction fremitus and friction sounds over the surface of the liver. These were very distinct, and I thought during life there must have been a large amount of perihepatitis. As stated in the post-mortem notes, the amount of perihepatitis was small and confined almost altogether to the nodules. The friction sound must have been produced by the rubbing of the rough cancerous surface over the peritoneum, also roughened by localized inflammatory action. It is doubtful if in any other affection of the liver than cancer could such marked symptoms be found.

(2) The rapidity of growth of the secondary nodules in the liver.

The diagnosis of primary carcinoma of the liver or gall bladder was made during life for the following reasons: (1) There was no history of primary cancerous disease in the pylorus, cæcum, or sigmoid flexure, or rectum. (2) There was a history of biliary colic, with inflammation of the biliary passages. (3) The absence of marked jaundice excluded the biliary passages.

We did not during life recognize the fact that the lower, smaller, and more prominent nodule, already described as existing in the upper margin of the right iliac fossa, was cancerous disease of the gall bladder, but we noted its early appearance. On post-mortem examination this tumor was found to be an outgrowth from the gall bladder, and this we therefore considered as the primary seat of the disease and that the invasion of the liver was of secondary character.

The presence of the calculi explained the illness three years before. They were probably the exciting cause of the carcinoma.

Diagnosis.—To make a diagnosis between cancer of the gall bladder and that of the biliary passages, although difficult, is not altogether impossible. In the former case the tumor is more superficial and much larger, and may exist some time before jaundice is developed. The position of the tumor in the gall-bladder region may aid in the diagnosis. Pain and tenderness are much more frequently marked.

Tumor of the bile ducts is smaller, more deeply seated, not so tender, and jaundice appears earlier.

The differentiation between cancer of the surrounding parts, the pylorus, duodenum, pancreas, and colon, from the form now under consideration is often difficult if not impossible. As a rule, the carcinomata of the gall bladder and biliary passages are attached to the liver, and the tumor moves up and down with the respirations. A careful study of the early symptoms and of the location of the tumor will assist the physician in arriving at a correct conclusion. The situation, size, and prominence of the tumor, together with the pain and tenderness, mark the presence of gall-bladder disease. The diagnosis from diseases not cancerous—cholelithiasis, for instance—may be made by the presence of emaciation and the peculiar character of the cachexia.

In the prognosis and treatment little more may be stated than what has already been given in the section on Hepatic Carcinoma (p. 563). The disease is nearly always fatal, and only such remedies should be administered as will relieve the sufferings of the patient. In a case which came under the writer's observation two years ago a complete cancerous occlusion of the common bile duct was attended by jaundice, and the

patient suffered from the most intense pruritus. The attending surgeon, Dr. Whiteman, performed a cholecystostomy, after which the bile flowed freely through an external fistula. The patient, who had been unable to sleep on account of the intense itching, was very much relieved. The jaundice disappeared, and three months of comparative comfort preceded the fatal result. When the character of the operation was explained to the patient he was quite willing to take all the risk in order to be relieved of the pruritus. Hochenegg[1] reports a case of removal of a cancerous growth involving the gall bladder and part of the liver. Recovery followed, and the patient, a woman, after some months appeared to be quite well. A similar case has since been reported of complete recovery after excision of a cancerous gall bladder.[2]

TUMORS OF THE LIVER AND BILE DUCTS OTHER THAN CARCINOMA.

Sarcoma, adenoma, and occasionally angioma are of clinical interest. Fibroma, lipoma, myxoma, and cysts, and usually angioma, give rise to no special symptoms, and are only of importance from a pathological standpoint.

Sarcoma of the Liver.

Sarcoma of the liver exists rarely as a primary disease, but is not infrequently found secondary to growths in other parts of the body. Podruczek has collected 13 cases of primary sarcoma of the liver, and the fourteenth, as stated by Eichhorst, was reported by Gubler.

In some cases of secondary disease the nodules may be so small that there is little hepatic enlargement and very few symptoms. On the other hand, the liver is sometimes enormously increased in size and the surface may be distinctly nodular. Lympho-sarcoma may exist in the liver as a diffuse infiltration. The form of the secondary disease will depend on structure of the primary growth. Cases of lympho,- myo,- fibro,- adeno,- and osteo-sarcoma have been reported. A myo-sarcoma secondary to a growth in the walls of the stomach has been described by Brodowsky.[3]

Byron Bromwell[4] has reported a case of enormous primary sarcoma of the liver in which a large blood cyst simulating a hepatic abscess was developed. The liver weighed nine pounds six ounces. The tumors occupied nearly the whole of the right lobe and part of the left.

Secondary osteo-sarcomata do not present the structure of bone, but occur in distinctly circumscribed nodes resembling medullary sarcoma.

Melano-sarcoma.—A single case of primary melano-sarcoma has been noted and accepted as genuine by Hanot. It is occasionally secondary to growths elsewhere, especially those springing from the choroid. The cut surface of a nodule of melano-sarcoma presents a blackish brown color sometimes mottled with white, and when the back of the knife is drawn over it a juice of a brownish color is collected. The semi-fluid matter

[1] *Medical Press and Circular*, Feb., 1890; *Med. Annual.*
[2] Heidenhain: *Deut. med. Woch.*, Jan. 2, 1897.
[3] *Virchow's Archiv*, Bd. 97.
[4] *Edinburgh Med. Journ.*, 1896.

is made up of serum and pigment. The centre of the nodules may degenerate into a black semi-fluid mass which is not absorbed.

Melano-sarcoma may exist as a diffuse infiltrated pigmentary mass, when the liver is increased in volume without much change in form. The external surface may remain smooth, but in places the sarcoma exists in large flattened nodules. The cut surface presents a peculiar mottled appearance not unlike granite (Hanot), thus giving rise to the term granite-like cancer.

In both forms, nodular and diffuse, the growth seems to spring from cells which have entered the liver through the hepatic artery, although this has not been proven. In one case of the infiltrated form, that described by Von Schüppel, the cells were introduced through the portal system, as the primary growth existed in the spleen and the infiltration was first intracapillary.

FIG. 32.

Melanotic sarcoma of the liver (Dr. Gordon's case).

The SYMPTOMS resemble those of carcinoma: the liver may be much enlarged, and friction sounds and fremitus on deep inspiration have been noticed in some cases. The presence of melanin in the urine is of diagnostic importance.

In the growth of sarcoma the substance of the liver seems to be quite passive and is only influenced by pressure of the tumor.

DIAGNOSIS.—In many cases sarcoma cannot be distinguished during

life from carcinoma. Murchison has given the following points, which may be of service:

(1) There may be no evidences of cachexia or emaciation;
(2) The amount of pain seems less;
(3) Jaundice and ascites are less often present;
(4) It occurs at an earlier age than carcinoma.

The presence of sarcoma in other parts of the body will often confirm the diagnosis of sarcoma of the liver.

The PROGNOSIS of hepatic sarcoma is equally hopeless with that of carcinoma, and the palliative TREATMENT is of the same character.

I am indebted to Gilbert Gordon of Toronto for the notes of the following case of apparently primary melano-sarcoma of the liver:

R. W——, a clergyman, æt. 78, father of a healthy family, all grown up. A brother and sister died of cancer. The patient has always been a strong, vigorous man, and had but one illness, malarial fever, sixteen years ago. About the middle of last month he felt a sudden pain in the back which lasted a few days, and since that time he has not been well. He had more or less anorexia and suffered from general malaise, although he attended regularly to business.

April 1st.—He has at present a pain more or less general over the right side, and is particularly tender over the intercostal nerves and over the region of the gall bladder. He also suffers from a pain radiating toward the right shoulder.

April 5th.—The pain is more localized over the region of the liver and is more acute on deep respiration. Anorexia is more pronounced; obstinate constipation and insomnia are more marked.

April 9th.—Sleeps fairly well after the administration of morphine and when the constipation is relieved. The temperature, which has been slightly raised, now reaches 100°, pulse 72. A distinct tumor can be felt over the liver, which is very tender on palpation.

April 11th.—Patient now remains in bed. Urine presents a dark smoky appearance; no albumin; bile pigment absent. Microscopical examination does not reveal anything abnormal. No blood cells.

April 19th.—Pain in the side more severe, felt especially on moving, yawning, or taking a deep breath. Pain now extends over the whole abdomen and there is much flatulence. Fine crepitation heard over the base of the right lung.

Patient was seen in consultation by W. P. Caven, who agreed in the diagnosis of malignant disease of the liver. The urine was examined by John Caven, who found it to contain melanin. This pigment was also found in the sputum.

April 21st.—Yesterday the pain over the abdomen increased in severity and the anorexia was more marked. Evening temperature was 101°. To-day the patient became suddenly worse. He suffered from great tympanites and much dyspnœa. He gradually became unconscious and died in the evening.

Post-mortem.—Melanotic deposits were found in the heart, liver, lungs, and kidneys, but the spleen was not affected.

A microscopical examination made by John Caven demonstrated the sarcomatous character of the growths in the liver. The short duration of the case is one of its marked features. Death took place two

months after the first symptoms and ten days after the patient had given up his ordinary work. Pain and enlargement of the liver were not marked until two weeks before death.

A rapid loss of flesh was manifested and the patient suffered from anxiety and great depression. Jaundice was not present at any time.

Melanin was present in the urine when the patient was first seen, and had existed for some time.

Insomnia was a constant symptom.

He had never suffered from any tumor of the eye or of the skin, and no evidence of a primary growth outside of the liver could be found on post-mortem. The brain, however, was not examined.

Spitting of blood and pigment began six days before death.

Adenoma of the Liver.

Cases of adenoma of the liver have been reported by Griesinger,[1] Rindfleisch,[2] Greenfield,[3] Kelsch and Kiener.[4]

The tumors are multiple, and vary in size from that of a pea to that of a hen's egg, usually not larger than a hazelnut. They are disseminated throughout the liver and appear in the form of slight elevations on the surface. The larger nodules have a capsule, and the smaller ones, although circumscribed, come in direct contact with the hepatic structure. They vary in color from a whitish gray to a yellow, and are raised above the cut surface. When vascular they may present a reddish color. The connective tissue of the liver is increased in amount. The larger nodules after a time undergo degeneration, and hemorrhages sometimes take place in the centre. So far as known, metastatic growths from the true adenoma do not occur.

E. Marckwald[5] has recently published his observation on hepatic adenomata, and concludes that they originally spring from the hepatic cell. They do not exist in any special part of the lobule, and there is no increase of connective tissue so long as the tumor exists within the lobule. He is of opinion that multiple adenomata of the liver are of malignant character. From records of cases it would appear that the condition varies very much clinically. In some cases the course is short, especially after the appearance of ascites, whereas in others the duration is much longer.

The dividing line between adenoma and carcinoma cannot always be drawn, and those cases in which metastatic growths occurred were probably cases of adeno-carcinoma.

On microscopical examination the nodules are found to be made up of tubules not unlike the convoluted tubules in the cortex of the kidney. These tubules are arranged in coils and are lined with epithelial cells. They often contain in their lumen a semi-fluid mucoid mass of a yellowish or greenish yellow color. The tubules are supported by a fine connective-tissue stroma in which there are a great many capillaries. The tubules spring from rows of hepatic cells, and the cells lining them originate directly from hepatic cells. In some cases the adenoma arises from the epithelial lining of the smaller bile ducts.

[1] *Archiv d. Heilkunde*, v., 1864, S. 385. [2] *Ibid.*
[3] *Transactions Path. Soc. London*, 1874, xxv. [4] *Arch. de Physiolog, norm. et path.*, 1876.
[5] *Virchow's Archiv*, 1898.

Von Schüppel was of the opinion that these tumors were under some circumstances transformed into carcinomata, and that the adenoma is a histological stepping-stone for primary cancer. Orth describes a case which in places exhibited a direct transformation of adenoma into typical carcinoma.

In some cases the relationship between adenoma and cirrhosis seems very close, and it may be possible that the same irritant which sometimes produces hyperplasia of the connective tissue may occasionally cause an increase of the glandular structure.

At the Surgical Congress of Berlin,[1] Von Bergmann presented a patient suffering from tuberous adenoma of the liver, from which he had removed a large piece. The wound healed rapidly, the abdomen became soft, and the margin of the liver could no longer be felt. He was of the opinion that such cases would be much improved by operation.

Cases have been reported of large tumors, apparently of an adenomatous character, of the true nature of which we are not yet certain. For instance, Hanks[2] reported a case in which he had made an exploratory incision, and found a tumor of an uncertain character springing from the lower portion of the liver and extending far beyond the median line down into the pelvis. The tumor appeared to be cancer and the abdomen was closed. Electrolytic puncture was twice made, but, as the patient did not bear it well, cutaneous application of the current with pressure by sponges was substituted. Some months afterward the patient was much improved in health and the tumor had lessened in size by about two thirds. The author wrote to Dr. Hanks with regard to this case, and in the reply, dated April 14, 1896, the doctor stated that the patient is still living and is well, to all appearance, but the tumor is now as large as ever.

Multiple cystic disease of the liver sometimes exists when there is a similar condition of the kidney and spleen. It is altogether distinct from the multiple hydatid of the liver, and from that condition which follows occlusion of the bile duct. In such cases the walls of the cyst are thin and the contents are clear and transparent. The cysts are often very numerous, and are, as a rule, not larger than a hazelnut. The substance of the gland is not destroyed to the same extent as in the kidney. In the latter organ the disease often follows a traumatism. Its origin is not well understood, but it is possible that it is somewhat similar in development to that of the cystic tumor of the ovary.

Angioma of the Liver.

Angiomata are usually found in elderly people, and are often situated on the upper surface or margins of the liver, most frequently on the upper surface near the suspensory ligament. They vary in size from that of a bean or even smaller to that of a walnut, but are usually small. They are of a dark brown or blue color, sharply defined, and when an incision is made blood flows freely and the walls collapse. These latter present a whitish surface lined with endothelial cells, and often contain involuntary muscle fibres. The hepatic structure in the immediate neighborhood may show signs of local cirrhosis. The origin of these

[1] *Medical Press and Circular.* [2] *N. Y. Medical Journal*, 1894.

tumors has given rise to some difference of opinion. Bruckhard[1] concluded that the blood from a ruptured blood-vessel formed a clot which, remaining connected with the vessel, becomes gradually changed into a connective-tissue capsule and is lined with epithelial cells. A new dilated channel is then made for the circulating blood. An angioma may be confused with a myxoma or a lipoma. The former tumor, however, can be injected through all three sets of vessels, according to Virchow and Mauer.

Some cases of angiomata in children have been described which increased in volume, forming quite a large tumor. Langerhans[2] reported an extraordinary case of multiple angioma. A young man in midsummer, after being overheated from exertion, became suddenly chilled. He felt weak and tired, and a few days afterward he consulted a physician. In September a pulsating tumor appeared in the left side, and in October an increase in the size of the liver was noticed which progressed steadily. About the last of November the case terminated fatally. Spleen and liver were found enlarged, and multiple angiomata were found in both organs.

FIG. 33.

Adenoma of duodenal end of the common bile duct.

[1] *Beiträge zur Path. anatom. des Cavern. Angiom. der Leber*, 1894.
[2] *Virchow's Archiv*, vol. 75.

Simple cysts are not frequently met with in the liver. Their formation has been explained by the transformation of rows of liver cells into the tubes like bile ducts, and these afterward become cystic. They are lined with ciliated columnar epithelium and contain clear fluid. These growths sometimes occur in association with adenomata.

The gall bladder and biliary passages are rarely the seat of tumors other than carcinomata. Polypoid tumors are sometimes found growing from the mucous membrane of the gall bladder, and fibromata in the walls have been described.

A case is reported by Allison of a fibroma situated in the walls of the common bile duct which produced obstruction and great dilatation of the passages, with intense jaundice. Von Schüppel has described a papillary myxoma of the gall bladder which strongly resembled a papillary carcinoma.

The following case of adenoma at the duodenal end of the common bile duct has been reported by my colleague, McPhedran: The patient, a man about fifty years of age, entered the hospital suffering from jaundice, which gradually increased in intensity and resisted all forms of treatment. Some weeks after his admission the patient was seized with rigors, high fever, and other symptoms of suppurative disease. The liver, which had previously been enlarged, became tender. The patient's strength failed rapidly, and death ensued.

Post-mortem by John Caven, to whom I am indebted for these notes as well as for the accompanying photograph: A growth was found in the walls of the duodenum which extended about half an inch into the common bile duct and a similar distance into the pancreatic duct. The two were separate and had distinct openings. The mass in the bile duct acted as a valve, producing obstruction. The liver was large, of a yellowish brown color, and with a slightly granular-looking surface. Recent adhesions were noted. Scattered yellow areas were found on the cut surface, varying in size from a pea to a ten-cent piece. These contained fluid consisting of bile and pus. The common bile duct was very much dilated and the walls thickened. It contained a greenish yellow fluid. The cholangitis had extended into the smaller ducts. The gall bladder was somewhat dilated and the walls were thickened, containing blood-stained mucus only.

Microscopical Appearances.—The duodenal growth was an adenoma of very regular structure. There was no infection of the lymphatic glands with secondary growths. The liver showed a diffuse cholangitis and pericholangitis, largely proliferative. The epithelium of the larger bile ducts was in a good state of preservation and the cells were enlarged. Throughout the liver, areas of necrosis were found from which the central necrotic mass had fallen out. Free spherical liver cells, granular in character, staining feebly, and often showing no nuclei, were found in the cavities. The endothelium was much swollen in places, and many leucocytes were found in the vessels beneath the capsule. Many hepatic cells showed the presence of fat and vacuoles. Section of the ductus communis choledochus showed marked inflammation of the inner surface.

BILIARY CALCULI; CHOLELITHIASIS.

Concretions varying in size, shape, and color are often found in the gall bladder and biliary passages, and occasionally in the liver and structures adjacent to it, as well as in the intestines. Cholelithiasis is a very common disease. Charcot found biliary calculi in one third of the post-mortem examinations made on aged women who died at the Salpetrière. The concretions are yellowish white, yellow, semi-transparent, or of dark brown color. Their cut surface often presents two or three different colors, arranged concentrically with radiating lines. They usually exist in greater or less numbers, but may be solitary. The number varies, as a rule, between five and thirty (Gamgee); 3000 calculi were found in a gall bladder by Morgagni, and 7802 by Otto (Breslau Museum). The shape depends on whether the concretions are single or multiple. When single they are usually found in the cystic or common bile duct, and are more or less oval; when a number are together they present flattened surfaces or facets. Sometimes a single calculus will present facets produced by others which have already passed into the intestine. A single gall stone of this kind was found by the writer at a post-mortem examination recently. There was a history of previous attacks and the margins of the facets were rounded. They vary in size from that of a grain of sand to that of a walnut, and are sometimes even larger. Von Schüppel records a case of Meckel's in which the calculus measured six by two and half inches. The smaller stones are most frequently found and occur in the largest number in one case.

They vary in consistence, but can, as a rule, be easily crushed. The principal constituents of gall stones are cholesterin and bile pigment.

Biliary calculi may be divided into four classes :

1. Those made up almost altogether of cholesterin ;
2. Those composed of cholesterin, bile pigment, salts of lime, and magnesia ;
3. Those consisting of bile pigment alone ;
4. Those made up of calcium carbonate.

The following substances are also occasionally found : margarate of lime, free fatty acids, mucus, epithelium, sodium chloride, copper, and manganese. Foreign bodies are sometimes found in the nucleus.

1. Calculi composed altogether of cholesterin are in the fresh state amber-colored and more or less transparent. They are generally single or two or three may exist together. They are roundish, varying from the size of a pea to that of a cherry, with a smooth or somewhat nodular surface. They break with a fractured surface which presents a glistening appearance. They are of a light specific gravity and can be easily cut. They are always heavier than water when in the fresh state, but when dried some will float on the surface.

2. The calculi most frequently found are composed of a varying proportion of cholesterin, with bile pigment and salts. They are usually multiple, and the surface is consequently more or less facetted; they vary in shape and size, and when single they are round or oval. They contain from about 60 to 80 per cent. of cholesterin, and the remainder is made up of bile pigment and biliary salts, with a small percentage of

inorganic matter. It is a singular fact that while the cholesterin exists in such a large proportion in the calculi, the quantity in the bile is very small—from .16 to .26 per cent.[1] Biliary coloring matter is found in the nucleus, in the middle zone, and in the outer crust. It is insoluble in water and in alcohol, slightly soluble in ether, but readily dissolved by chloroform. Calcium carbonate and manganese salts are also found in this variety.

These calculi have usually a definite structure. They are made up of a nucleus, of a middle, and an outer layer or rind. The nucleus is composed of coloring matter, sometimes around a foreign body, and is usually in the centre and single. It may, however, be eccentric, and is sometimes multiple. As many as five nuclei have been found in one calculus. In such cases single stones have become agglutinated in the early stage of their growth.

A variety of foreign bodies have been found in the nucleus—a desiccated ascarus lumbricoides, bacteria, a needle, a small mass of dried blood, and Thudicum reported a case in which casts of the small intra-hepatic ducts formed the nucleus.

The middle zone or shell is made up largely of crystals of cholesterin which present a glistening appearance. The amount of bile pigment varies, and gives it a brownish or brownish yellow color. The cholesterin crystals are often arranged in concentric circles. The outer layer or crust is hard and laminated. It is sometimes composed of cholesterin, sometimes of bile pigment, and occasionally of calcium carbonate.

Chemical Composition.—The following table, from Robin,[2] gives a good idea of the proportionate amount of the various ingredients in eight calculi, representing all the varieties known:

Composition of different kinds.	1st.	2d.	3d.	4th.	5th.	6th.	7th.	8th.
Cholesterin	98.1	97.4	70.6	64.2	81.4	84.3	trace	0
Organic matter	1.5	2.1	22.9	27.4	15.4	12.4	75.2	18.1
Inorganic matter	0.4	0.5	6.5	8.4	3.2	3.3	24.8	91.9
Number of specimens . . .	28	16	580	94	220	16	3	1

3. Those composed altogether of pigment are small, brittle, of a red brown, green, or black color, and homogeneous in structure. They are usually found in the intra-hepatic biliary canals.

4. Calculi of calcium carbonate present a white or grayish white appearance, are hard and heavy. They occur in cases of cancer, and are sometimes formed after the commencement of that disease.

Naunyn classifies gall stones into the following varieties: (1) pure cholesterin, (2) laminated cholesterin stones, (3) the common gall-bladder stones, (4) mixed, (5) pure bilirubin calcium calculi, (6) the rarer forms.

The conditions of the bile and blood which lead to the formation of calculi are not well understood. Cholesterin is found in large quantities in nervous tissue and in the blood. It is in greater proportion in the red blood-corpuscles than in the serum. It exists in solution in the bile,

[1] Cholesterin exists in a much larger proportion in the bile found in the gall bladder.

[2] Pepper's *System*, vol. ii. p. 1060.

and is thus eliminated from the body. The amount given off through the fæces in twenty-four hours is about forty-five grains. It is maintained in solution in bile by the alkaline biliary salts and by the soaps of potash and soda. If it exists in excess, it may be precipitated, but, according to Naunyn, the amount found in the bile is very constant. Its precipitation, therefore, in the formation of calculi must in the great majority of cases be explained in some other way than by excess. It is probable that a diminished alkalinity of the bile tends to a precipitation of the cholesterin. An excess of organic acids in the fluids of the body may act in two ways: First, they may to a great extent lessen the alkalinity of the bile; second, they may set lime free in the tissues, which when brought to the liver may combine with biliary acids, forming more or less insoluble salts, and thus break up the salts of potash and soda, the presence of which seems to be essential to the proper solution of the cholesterin. Morgagni pointed out the great frequency with which biliary and renal calculi are found in the same individual. A lithæmic condition would predispose to both.

It is probable also that a microbic biliary catarrh may set up a local acid condition which would result in the precipitation of the cholesterin, and this is more likely to be the case from the fact that an inflamed biliary epithelium excretes an abundance of cholesterin. Professor Welch of Johns Hopkins Hospital has reported a case in which the bacterium coli communis was found in the centre of the biliary calculus.

It is probable that in many cases a catarrhal condition of the bile ducts is a predisposing cause, and that the nuclei of the gall stones formed of necrosed epithelium are surrounded by precipitated cholesterin and bile pigment.

The influence of typhoid fever in the formation of biliary calculi has recently received a good deal of attention, and has been referred to in a paper by Osler on the "Hepatic Complications of Typhoid Fever." Eberth's bacilli have frequently been found in the gall bladder, and it is probable that the catarrh thus produced may end in the formation of gall stones, especially since cholesterin is found in larger amount under such circumstances. One must not forget, however, that in many cases in which the symptoms of cholelithiasis follow typhoid fever calculi may have existed in the gall bladder previous to the onset of the fever.

The clinical conditions which lead to the formation of calculi are better understood than the chemical changes which take place previous to their formation.

Etiology.—*Sex.*—Gall stones are more prevalent in the female, the proportion, according to Bouchard, being 100 to 66. According to Schroeder of Strasburg, they are four and a half times more frequent in females than in males. The proportion, according to Frerichs, was as 3 to 2, which is probably correct. They occur in women much more frequently during the childbearing period, from twenty-five or thirty to fifty. At this time less CO_2 is given off from the body. The causes which in females may assist in the formation of calculi are the wearing of corsets, sedentary habits, and greater or less prolapse of the liver. All these conditions hinder the flow of bile and produce a diminished alkalinity of the secretion, both of which predispose to the formation

of gall stones. Marchant has observed that gall stones and tight lacing often occur together, and is of the opinion that there is a direct relationship between them. According to Bollinger, 40 per cent. of women with gall stones also exhibit corset liver. The pathological changes in the liver produced by direct pressure have a tendency to obstruct the flow of bile.

Age.—In 1000 cases, according to Harley, 750 occurred in patients over forty years of age, 200 between thirty and forty, 40 between twenty and thirty, and 10 under twenty. Trousseau has observed cholelithiasis in a female nine years of age. Biliary calculi have been found in newly-born infants. Portal reports a case in a child who died on the twenty-fifth day after birth from obstructive jaundice. Frerichs reported a case of gall stones in a child who suffered from chronic hip disease and consequent amyloid liver.

In Colney Hatch Asylum for the Insane gall stones were found in 36 per cent. of all cases. In none were there any symptoms pointing to their existence during life. The great prevalence of biliary calculi in the insane may be explained by the fact that cholesterin is found in largest quantity in the nerve tissues.

All conditions which lead to incomplete oxidation predispose to gall stones, as sedentary habits, old age, bad hygienic surroundings, and cold, damp climates. Obesity, acute rheumatism, gout, chronic rheumatism, lithæmia, and atheroma are frequently found in those suffering from calculi. Cancer of the stomach and liver also predispose to cholelithiasis. In females there is a marked relationship between diabetes and biliary calculi. They are much more common in the middle and upper classes than in the poor, and, according to Budd, they are rarely found in sailors. It will thus be seen that those conditions of life in which the circulation is charged with the products of malassimilation are those in which there is a greater predisposition to cholelithiasis.

The effect of diet in the formation of gall stones is not well understood. It is probable that food which increases the acidity of the excretions may predispose to the formation of calculi. It was observed by Glisson that gall stones were found more frequently in cattle and sheep in the springtime than at any other season. He ascribed it to the dry food given through the winter, and green vegetables were therefore recommended for the human subject. It is probable, however, that the want of exercise during the winter was the real cause of cholelithiasis. Frerichs thought that small meals and too long an interval between them tended to the formation of calculi, as the gall bladder was not thoroughly emptied.

Trousseau was of the opinion that there existed in some cases an hereditary tendency to the formation of calculi. Frerichs, on the contrary, thought that the presence of urinary and biliary calculi was an accidental circumstance and that no special diathesis existed.

Locality.—Gall stones are found with greater frequency in some countries than in others. Cholelithiasis is a common disease in Hanover, Sweden, and Hungary. It is quite infrequent in Holland and Finland. Some have supposed that the greater frequency in some localities than in others was owing to the drinking water containing a greater amount of lime, but this has not been proven.

Climate does not appear to exert any special influence. It was at one time thought that gall stones occurred less frequently in tropical countries, but this has not been confirmed. Changes in the liver and bile ducts whereby the current is obstructed predispose to the formation of biliary calculi. Repeated attacks of catarrhal cholangitis may act in the same way.

The presence of *foreign bodies* is not a frequent cause, although a few cases have been reported. Shreds of necrosed mucous membrane and parasites have been occasionally found. Globules of quicksilver were found in a patient who had used mercurial ointment freely for syphilis. A plum stone formed the nucleus of a gall stone in one case.

Symptoms.—Calculi may remain latent in the gall bladder for years without producing any very marked symptoms. Their passage through the natural channels, the cystic and common bile ducts, is usually accompanied by more or less severe pain, with spasmodic contractions of the ducts themselves. The force which propels the calculi is produced by contraction of the abdominal muscles and the muscular fibres of the gall bladder. They are frequently arrested in the cystic duct and near the duodenal opening of the common bile duct. Their arrest in the cystic duct is partly due to narrowing and partly to the peculiar arrangement of the fibres known as Heister's valve. The accumulation of mucus which often so distends the gall bladder may act as an expelling force when the stone is lodged in the cystic duct.

The symptoms caused by the passage of gall stones are so numerous that an attempt has been made to classify them. Charcot makes the following division: First, Nervous symptoms the result of irritation, biliary colic. Second, Hyperpyrexia, the result of absorption from the biliary passages. Third, Symptoms due to obstruction.

A very important series of symptoms is described under Hepatic Colic. The pain usually commences three or four hours after a meal, when the chyme passes in large quantities from the stomach into the duodenum and the gall bladder contracts on its contents. Cases have been recorded in which the pain came on when the stomach was empty. Harley states that this is the usual time for pigmentary calculi, inspissated bile, to find their way through the passages. The pain is often preceded by nausea and a feeling of distention of the abdomen, nervous excitement, yawning, and shivering.

Sometimes shaking or jarring of the body, a direct blow, or mental emotion may dislodge a calculus which is afterward propelled along the passages. The severity of the pains and the frequency of the attacks depend upon the shape rather than upon the size of the calculus. The roughness of the stone acts as an irritant in producing spasmodic contraction of the muscular fibres of the ducts. It is probable that in some patients spasmodic contractions are caused more readily than in others. Jonathan Hutchinson has recently recorded a case in which a stone measuring one and a half inches in its long diameter passed through the biliary canal without the least pain or inconvenience. In fact, it has been shown that a real spasmodic contraction of the biliary passages, a true hepatic colic, may occur without the presence of gall stones. The passage of the first calculus is usually accompanied by much more severe pain than the passage of subsequent ones. Hepatic

colic sometimes occurs in connection with menstruation, pregnancy, and accouchement. The pain may be gradual or sudden in its onset, and is of an acute, tearing, expulsive, paroxysmal character, increased by pressure and darting toward the right shoulder. It may radiate toward the right hip and testicle. Cases occur in which it is not severe and does not extend either upward or downward. It may be felt principally in the back, and is sometimes periodical, resembling malarial neuralgia. An old author describes an exacerbation as follows: "It may be a mere paroxysmal twinge or it may be the most excruciating agony, driving the strongest nerved man to shed tears like a child." The severity of the pain is due to the rich nerve supply of the large bile ducts. Women who have borne children state that the pains of labor are not nearly so severe nor so difficult to bear as those of biliary colic. The countenance may be pale and agitated, eye fixed, and the forehead covered with perspiration. The patient may toss from side to side on his bed or may rest on his knees, bending his body forward. The decubitus is usually on the left side. The walls of the abdomen are rigidly contracted, but often do not present any deviation from normal. In the beginning of an attack pain is relieved by pressure, but after a time the abdominal walls are excessively tender. In the commencement also the pulse may be quiet and there may be no elevation of temperature. In some cases, however, the temperature rises rapidly. Chilly sensations often precede the rise of temperature. According to Fürbringer, fever in the course of hepatic colic is more common than is generally stated. Peter has shown that there is an increase in temperature during the exacerbation. The attacks last usually from three to five hours, and, as a rule, vomiting occurs just before the cessation of the pain. The contents of the stomach are first expelled, and then an acid fluid. If bile is vomited, the common choledoch duct is not completely obstructed. In some cases a complete recovery may take place after a series of paroxysms, whereas in others the attacks may recur every few days, when jaundice usually appears. Occasionally an attack may only occur every few months or after an interval of some years. The patient may be quite well between the exacerbations, but so long as calculi are present there is often a feeling of uneasiness with more or less subicteric tint in the skin. Dyspeptic symptoms are often present, and the patient is depressed and irritable. If the pain in a single attack continues for twenty-four hours, jaundice may occur, and its severity depends upon the amount of obstruction and the length of time it has been in existence. When jaundice is absent the calculus may not have remained in the common bile duct long enough to cause it. The stone may lodge in the cystic duct or it may ulcerate through the walls of the gall ducts, so that it does not act as an obstruction. When a calculus in the common duct is small and angular, it may allow bile to pass around it. In many such cases, however, when jaundice is not present bile pigment is found in small quantities in the urine, and its importance as a diagnostic sign has of late received a good deal of attention.

The duration of the jaundice depends on the number and size of the stones. It may last from two days to two weeks. Permanent occlusion of the common bile duct does not often occur unless there is a

good deal of inflammation. As a rule, when a calculus passes through the cystic duct it can also go through the common bile duct. When a large stone has forced its way through the natural channels, smaller ones pass into the intestine without causing much pain or obstruction. If the attack of biliary colic is prolonged, the liver becomes enlarged and the gall bladder may be sufficiently distended to be easily felt.

After a series of attacks jaundice may appear on the second or third day. It is the result of obstruction of the common bile duct, which is usually produced by a gall stone becoming lodged either in the distal end of the cystic duct, thus pressing on the common choledoch, or in the common bile duct itself near the duodenal opening. The author has noticed some cases in which the cystic and common hepatic duct run together for half an inch or more before a junction is made. In such cases a gall stone in one would obstruct the other.

The calculus may remain in the gall bladder, and at each paroxysm of pain be forced into the cystic duct, or it may become lodged there. In either case jaundice does not occur as long as the common bile duct remains free. According to Charcot, jaundice occurs from five to six hours earlier in biliary obstruction than in catarrhal trouble. Gall stones do not necessarily cause jaundice. In 45 cases recorded by Wolfe it occurred in only 20. According to Harley, intrahepatic gall stones are not often accompanied by jaundice or by severe pain. The prognosis in biliary calculus does not necessarily depend on the intensity of the jaundice.

Accessory Symptoms.—In the hysterical or epileptic type the patient may have a convulsion during an attack, and the phenomenon of inhibition or shock may be specially marked. Cases of death have been reported from this cause in which on post-mortem examination nothing has been found more than the presence of the calculus in the duct. A case is reported in which the patient died from a convulsion, probably from the arrest of the heart's action in diastole. Functional derangements of the heart, such as palpitation and irregularity, are not uncommon. Hemiplegia and paraplegia have been known to follow hepatic colic. Acute dilatation of the heart, shown by the increase of the area of cardiac dulness, tricuspid insufficiency, and dilatation of the jugular veins have been reported. These may be partly due to a fatty degeneration of the heart which frequently accompanies jaundice or to a contraction of the capillaries of the lungs, as is supposed by Potain.

Gall stones may follow any of the following courses:

1. Passage through the ducts.
2. More or less permanent arrest in the gall bladder or ducts.

a. With arrest in the gall bladder there are
- No symptoms or cholecystitis of either a catarrhal or suppurative character;

b. With arrest in the cystic duct there may be
- Distention of the gall bladder with bile;
- Distention of the gall bladder with mucus;
- Hydrops felleæ;
- Atrophy of the gall bladder;
- Bile not obstructed.

c. With arrest in the common bile duct, { Distention of the gall bladder and ducts with bile or mucus; Obstructive jaundice; Absence of jaundice.

d. Arrest in the intestine, — Symptoms of intestinal obstruction.

3. Migration of gall stones outside of the natural passages.

2. Arrest in the Gall Bladder or Duct.

The gall bladder may contain a large number of calculi for years without the presence of any marked symptoms beyond a feeling of pressure and distention in the hepatic region. Catarrhal or suppurative inflammation may at any time arise, and the viscus may become so distended that its position can be easily outlined by palpation. Adhesive peritonitis and perihepatitis may supervene in some cases, and the absorption of pus may result in general pyæmia. The gall bladder may rupture into the peritoneum, causing a fatal peritonitis. In some cases ulceration of the wall of the gall bladder may be followed by absorption of pus.

When a calculus is arrested in the cystic duct it may act as a valve, allowing bile to flow in, but obstructing its exit. In a great many cases the gall bladder is distended with mucus with only a trace of coloring matter. Again, after a longer or shorter time, owing to the absorption of mucus and to cholecystitis and perihepatic inflammation, atrophy of the gall bladder may take place. When a patient has suffered some years from attacks of biliary colic the gall bladder will probably not be distended, as the thickness of the wall and the surrounding adhesions will prevent it. For this reason a distended gall bladder is found in only a small proportion of cases of calculous obstruction of the common bile duct—in 17 out of 87 cases, according to Courvoisier. The calculus may not be large enough to obstruct the flow of bile, although it may cause frequent attacks of pain. In some cases the stone falls back into the gall bladder and the pain suddenly ceases.

Instances have been reported in which calculi were found on post-mortem examination lodged in the cystic duct when no symptoms were complained of during life. In such cases there is an absence of spasm, and the first sign of the closure of the duct may be distention of the gall bladder. In the majority, however, there is severe spasmodic pain, followed by signs of distended and tender viscus.

When calculi become lodged in the hepatic duct so as to produce obstruction, enlargement of the liver, dilatation of the ducts, and all the symptoms of obstructive jaundice supervene without distention of the gall bladder.

Sometimes the more or less permanent arrest of calculi in the biliary passages is accompanied by a train of symptoms to which the term "hepatic intermittent" has been given by Charcot. This is to be distinguished from the febrile condition which sometimes accompanies hepatic colic. Hepatic intermittent may occur when the calculi completely obstruct the bile duct or when they lie loosely in the passages. It is also sometimes present in other forms of obstruction. It commences suddenly with a severe rigor, during and after which the temperature may rise to 103°, 104°, or 106° F. This is followed by a sweating stage which

is very pronounced, but which in some cases is absent. In the interval the temperature is normal. Jaundice may or may not be present, depending on the amount of obstruction. The chills may be preceded or followed by the pains of hepatic colic, but in some cases there is a complete absence of pain.

A marked feature of this condition is the diminution in the amount of urea excreted, differing in this respect from other febrile conditions. This diminution is especially marked during a rigor, as has been shown by Charcot. While the total quantity of urea is diminished, leucin and tyrosin crystals are found in the urine. The probable explanation of this phenomenon lies in the fact that the ureaginous function of the hepatic cells is seriously interfered with and the leucin and tyrosin have not been transformed into urea.

Hepatic intermittent fever may last for two or three months, chills coming on at intervals of eight, ten, or fifteen days. Thirty-one exacerbations were noticed by M. Regnard in one case. It terminates fatally in the majority of cases. The patient sinks into a low typhoid condition, exhibiting symptoms of blood-poisoning. Some recoveries have been recorded in which the symptoms subsided after the expulsion of calculi. Interesting cases of this condition have been published by Osler. The differentiation between this and malaria may be made by noting the regularity of the chills and by an examination of the blood. The chills of malaria are more regular in their occurrence, and the blood will show the presence of Laveran's organism in great numbers when the rigors are so severe. Then, in the latter case, quinine will prevent further exacerbations, while it will have no effect in hepatic intermittent fever.

In pyæmia the fever is more frequently remittent, and the temperature does not become normal during the interval. The presence of localized inflammation and increased leucocytosis will also distinguish pyæmia.

Cholelithiasis with suppurative cholangitis or cholecystitis may be distinguished by the temperature remaining elevated during the intervals and by the signs of local inflammation.

Hepatic intermittent fever occurs when the biliary passages are quite free from pus, but it is probable that some other toxin exists at the seat of obstruction and becomes absorbed.

Arrest in the common bile duct causes distention of the bile ducts above the seat of the gall stone, and is followed by obstinate jaundice which usually lasts as long as the obstruction. The bile in the dilated intrahepatic duct has a tendency to become more dense, and pigmentary calculi frequently form. The usual seat of arrest is near the duodenal opening. The liver is enlarged at first, but may afterward become diminished in size. The hepatic cells may lose their functional activity, as shown by the diminution in the excretion of urea, the presence of glycosuria, of leucin, and tyrosin in the urine, and all the symptoms of general intoxication. If the stone is not large enough to fill the duct, the jaundice may be intermittent or altogether absent. At any time a catarrhal or suppurative cholangitis may ensue, with symptoms and consequences already described. The portal vein may become obstructed and pylephlebitis follow.

3. Migration of Gall Stones Outside of the Natural Passages.

Two classes of cases may here be distinguished:

(*a*) In the first group may be arranged all cases in which the perforation is suddenly produced. The calculus may be expelled through the walls of the gall bladder during a violent effort, owing to excessive tension of the surrounding parts and of the part in which the calculus is lodged and the spasmodic contraction of the muscular fibres of the gall bladder itself. Sometimes this occurs during a violent fit of coughing or repeated vomiting. Rupture has taken place in labor. The calculus when expelled falls to the bottom of the peritoneal cavity, and an abundant flow of bile takes place into the abdomen. If the latter is aseptic, peritonitis may not occur, or if it does it may not prove fatal. In a case recently recorded by a French writer twenty-seven litres of bile were aspirated from the peritoneal cavity in twenty-nine days without any sign of peritonitis. Recovery took place.

The pain produced by rupture is of a tearing character, somewhat similar to that experienced at the commencement of pneumo-thorax. The patient may pass into a state of collapse with subnormal temperature, small pulse, and a distended abdomen. If he recovers from this, a typhoid condition may follow which soon terminates in death. A severe hemorrhage into the peritoneal cavity has been the cause of a fatal result in some cases.

(*b*) Perforating ulceration is a much more frequent process than sudden rupture. An abnormal communication may thus be established between the gall bladder and the walls of the abdomen or the cavities of neighboring organs. Calculous biliary fistulæ are, as a rule, preceded by cholecystitis and localized cholangitis. The walls become thick in some places and thin in others, and a subacute peritonitic inflammation occurs in the situation of the calculus. Ulceration may follow, and a process similar to that which occurs in appendicitis is then established. An abscess is formed which may rupture through the abdominal walls into the bowel or into the peritoneal cavity. This is attended by all the symptoms of an abdominal abscess. Biliary cutaneous fistulæ are generally found under the false ribs on the right side or near the umbilicus. In rare cases the exit occurs in more remote parts—for instance, above the pubes or in the inguinal region. When the abscess is opened and its contents evacuated, bile may again pass through the natural channels and the fistula close up. As a rule, however, the fistula remains open for a long time, and may give rise to erysipelas or septicæmia. Many remarkable cases of biliary fistula have been recorded. Harley places on record the case of a man ninety years of age who passed three gall stones through an opening near the umbilicus, the largest weighing 180 grains. A women sixty years of age, who had at thirty-two suffered from jaundice, passed through a fistula a biliary calculus an inch and a half long by three quarters of an inch in diameter. She made a good recovery. Fräntzel reports a case in which 177 calculi were passed from a biliary fistula in one day and 306 in a month.

As a rule, biliary fistulæ opening into the gastro-intestinal canal are more favorable than those opening externally. The calculi may pass

directly into the intestine or through a previously existing abscess or cyst. During the process the general symptoms of abscess may be present, with much local tenderness and swelling. The rupture is generally accompanied by severe pain, followed by the disappearance of the tumor and the presence of bile in the fecal matter; vomiting of the contents of the stomach, hæmatemesis, and melæna are often accompanying symptoms. A rapid recovery sometimes follows or complications arise, such as cholangitis and general peritonitis. The calculi may pass rapidly through the intestine or become arrested and form an obstruction. The usual situations of arrested calculi are the duodenum, the cæcum, the sigmoid flexure, and the rectum. Enteritis may be caused by gall stones. When the calculus is arrested in the duodenum its situation may be diagnosed by the early onset of vomiting and by its persistent character. The small quantity of urine voided is another important symptom. In some cases there is almost complete anuria.

In this connection the following unusual case, which came under the observation of the writer, is of interest: The patient, a married woman fifty-two years of age, had suffered on three or four occasions from biliary colic. In the month of May she had a recurrence of the colic, followed by slight jaundice. She did not appear to recover from this as she had from former attacks. During June and July she complained of more or less pain in the stomach and of the symptoms of dyspepsia. In August, after an unusual amount of exertion, symptoms of gastritis appeared which were aggravated by the taking of food. These symptoms increased in severity until the patient was unable to take any food, not even a teaspoonful of milk, without causing pain and vomiting. In November the patient was much emaciated; the skin presented a slight subicteric tint, but she complained very little of nausea, and said she would be quite comfortable if she could live without eating. She was sustained by nutrient enemata. A small quantity of blood had been vomited on two or three occasions. Physical examination did not reveal anything except a slight induration over the pyloric region. The rectus muscle on the right side was more tense than normal. The stomach was not dilated nor the liver enlarged. The urine contained a small amount of bile pigment, and was sometimes slightly albuminous. She died in the early part of December.

On post-mortem examination a calculus was found in the ampulla of Vater which caused partial intestinal obstruction. A catarrhal inflammation extended from the seat of the calculus up to the pyloric orifice and into the stomach, occupying the left third of the mucous surface. An ulcer was found about the size of a large penny, commencing about half an inch from the pyloric orifice and extending along the anterior wall. The base was more or less ragged, and on microscopical examination the upper two thirds of the mucous membrane was found destroyed, and round-celled infiltration existed in the deeper part that remained. The calculus, while it did not produce complete biliary or intestinal obstruction, caused a dilatation of the duodenum. A catarrhal inflammation probably commenced in the duodenum and extended to the stomach. The ulceration may have resulted from the action of the gastric juice on an already inflamed mucous membrane. The promi-

nence of the symptoms of gastric ulceration obscured those of obstruction by the biliary calculus.

Körte[1] reports a case of intestinal obstruction due to gall stones which was successfully treated by operation. The abdomen was opened, and in some coils of intestine which had dropped into the pelvis a gall stone was found some twenty or thirty centimetres from the ileo-cæcal valve. The intestinal wall was tightly stretched over it. In two other cases Körte operated successfully.

The mortality in cases of intestinal obstruction from gall stones is very great—about 56 per cent. The concretions may cause an obstruction which results fatally, or they may produce ulceration and gangrene of the intestinal walls. W. H. Draper of New York has reported 2 cases of arrest in the duodenum. In both the onset of vomiting, pain, and distress was very sudden. One was operated on early and recovered. In the second case the patient would not consent to an operation until too late.

If the calculi are small, they may enter the appendix and produce appendicitis. When found in the rectum they are usually large and often difficult to dislodge. Some cases of vomiting of calculi have been reported. They enter the stomach either directly by means of a fistula or indirectly through the duodenum.

In some rare cases, fistulæ, the result of cholelithiasis, may pass up through the diaphragm into the mediastinum, the pericardium, the pleura, or into the lung, forming in the latter case broncho-biliary fistulæ.

Courvoisier in 1890 collected 24 cases of such fistulæ, in 11 of which cholelithiasis was the cause. I have collected 7 additional cases of the latter variety. One case came under my own observation in a man who when thirty years of age suffered from a rather severe attack of biliary colic, all symptoms of which passed away in about six weeks. This attack was accompanied by fever, but not by jaundice. Three years afterward he had a similar attack, which was accompanied by what appeared to be a localized pneumonia in the lower and anterior portion of the right lung. He then began to cough up bile, which in a few days increased in quantity, so that from one to two pints were expectorated daily. The patient became slightly jaundiced. After a few weeks the symptoms gradually subsided and the expectoration of bilious fluid ceased. The patient had a slight return of the trouble three months afterward, and then enjoyed good health for a period of ten years. He then suffered from a third attack of severe pain in the hepatic region, accompanied by fever and followed by jaundice. A few hours after the commencement of the attack he coughed up bile, and continued to do so more or less daily for a period of six months. The quantity expectorated varied very much, from a few ounces to two pints. On two occasions there were intervals of a few days when no bile was coughed up.

Eight months after the beginning of his illness an operation was performed by Sweetman of Toronto. Two calculi were found in the common bile duct and some in the gall bladder. The common duct was so imbedded in fibrous tissue that the calculi could not be removed. It was not possible to make an external fistula nor to make

[1] *Deutsche medicinische Wochenschrift*, Feb. 29, 1894.

an anastomosis with the duodenum. A cholecyst-colostomy was done as the only feasible operation.

The patient did fairly well for a few days, but the bile continued to be expectorated, and the constant cough interfered with the healing of the wound.

In the second week a pneumonia took place in the right lung, which closed up the fistula, and the patient afterward became intensely jaundiced. Death from cholæmia and consequent hemorrhage occurred on the thirteenth day after the operation.

These fistulæ into the pleura and lung may arise from cholelithiasis in three or four different ways:

(1) The occlusion of the common bile duct may be followed by a suppurative cholangitis and the formation of abscess in different parts of the liver. A large one near the convex surface may extend upward through the capsule and diaphragm into the pleura, or through into the lung. The dilated biliary canals will allow of the free flow of bile into the bronchi.

(2) After the closure of the ductus communis choledochus concretions of bile pigment may form in the intra-hepatic ducts, and these may become the centre of an abscess which, if it exists near the convex surface of the liver, may find its way into the lung in the manner already described.

(3) Calculi from the cystic or hepatic duct may ulcerate through the liver substance, resulting in an abscess which may perforate into the lung.

(4) Rupture of the gall bladder may take place and an abscess form on the upper surface of the liver. This may afterward rupture into the pleural cavity and lung, and a direct communication be thus formed between the gall bladder and bronchi.

A case of perforation into the kidney and the passage of a gall stone through the ureter has been recorded; also a case of perforation into the uterus and vaginal canal.

Diagnosis.—Hepatic colic is to be differentiated from pleurodynia, intercostal neuralgia, angina pectoris, gastralgia with spasmodic contraction of the pylorus, pleurisy, intestinal colic, renal colic, hepatic neuralgia, floating kidney, intestinal obstruction, psoas abscess, aneurysm of the cœliac axis or abdominal aorta, typhlitis, perityphlitis, cholera, and acute poisoning.

In pleurodynia the pain is more localized, and there is no tenderness over the hepatic region. Pyrexia and other signs of hepatic disease are absent, and the symptoms of muscular rheumatism are present in other parts of the body.

In intercostal neuralgia the three painful points of Valleix can be readily made out, and a similar pain is frequently present in other parts of the body, while the ordinary symptoms of hepatic disease are absent.

Angina pectoris is differentiated by the seat of pain, the fear of impending death, and the increased tension of the pulse.

In gastralgia the pain will be increased by drinking cold water, and it is more directly connected with gastric disturbances. When jaundice follows the biliary obstruction and the enlarged gall bladder can be felt through the walls of the abdomen, the differential diagnosis is made with

ease. The diagnosis between cystic colic and gastralgia accompanied by contraction of the pylorus is often extremely difficult. If the patient is examined during an attack, distention of the gall bladder or of the stomach may be distinguished in either case. The pain is seated in the stomach, and is lessened by pressure, whereas in hepatic colic the pain is in the region of the liver and the surface is tender on pressure.

The pain of gastric ulcer resembles that of biliary colic very closely, and mistakes are not infrequently made. In both the pain and tenderness are in the same region, and in both an exacerbation may take place after eating, although in biliary colic the latter does not occur so constantly as in gastric ulcer, and the kind of food will produce a more decided effect in gastric ulcer than in cholelithiasis.

In cases of biliary colic an interval of a week or more may occur between the attacks, whereas in gastric ulcer the pain is experienced after almost every meal. When the contents of the stomach are excessively acid, ulcer is probably present. Jaundice and enlarged gall bladder would complete the diagnosis. In a case the report of which has already been given the gastric symptoms were so prominent as to mask those connected with the biliary obstruction.

Pleurisy can be differentiated by a careful examination of the chest. This should be made in every case.

Intestinal colic may be relieved by pressure and may differ in location. Lead colic is accompanied by other signs of lead-poisoning—blue lines on the gums, paralysis, etc. Very good authorities, especially the French, have recognized an hepatic neuralgia (hepatalgia) in patients of a neurotic temperament which may be mistaken for biliary colic.

Renal colic may be distinguished by the different situations of the pain and from its shooting down toward the bladder and genital organs. In some cases the pain of renal colic spreads to neighboring organs and the differentiation may be difficult. A careful examination of the urine may reveal the presence of blood, mucus, and crystals.

The following case illustrates the difficulty of differentiating between these two conditions: The patient, a female fifty-two years of age, had suffered for years from a sharp, severe, spasmodic pain in the gall-bladder region, which was accompanied by a distinct, somewhat elastic swelling. The latter was not tender at first, but afterward became so. The patient could frequently relieve the pain by bending toward the right side and pressing with both hands over the hypochondrium upward, backward, and inward. She felt something give away and the relief was instantaneous. Occasionally she could not terminate the attack in this way, and it was necessary to give her several large doses of morphine. These attacks came on irregularly, often two or three in a month.

The patient came under the writer's observation when she had suffered for hours from pain and vomiting, and several hypodermic injections had been given. A distinct elastic tumor was felt in the right hypochondrium, which was very tender on pressure. The patient had fever, and within the next few days she suffered from two or three distinct rigors.

The diagnosis was made of gall stone in the cystic duct, with consequent distention of the gall bladder; but no explanation could be given of the process whereby she had so frequently been able

to relieve herself of pain. The urine was examined, and found free from bile pigment, pus, blood, or any other abnormal sediment.

An operation was done by Ross, and the elastic swelling was found to be a displaced suppurating cystic kidney, tensely distended and pressing upward on the neck of the gall bladder and common bile duct. The gall bladder was somewhat larger than normal, but no biliary calculi were found, nor urinary calculi found in the kidney. The patient had suffered since childhood from angular curvature of the spine, and this may have accounted for the extraordinary conditions found.

Malarial neuralgia is distinguished by the periodic character of the exacerbations, by enlargement of the spleen, by its subsidence after the administration of quinine, and by the presence of the plasmodium in the blood-corpuscles.

During a cholera epidemic a case of hepatic colic with watery diarrhœa, great weakness, and huskiness of voice may be mistaken for Asiatic cholera.

The important diagnostic points in gall-stone disease are the recurrence of attacks of biliary colic, which may or may not be followed by jaundice, and the presence of calculi in the fecal evacuations. The latter is of course decisive, and a careful search for stones should always be made. They are, as a rule, easily found, as the brown is quite a contrast to the clay color of the fæces.

It must here be remembered that even in those cases in which jaundice is absent from the skin the urine, when carefully examined, may give evidence of the presence of a small amount of bile pigment. In such cases it is probable that the bilirubin finds its way into the circulation through the ulcerated surface of the cystic duct produced by the presence of the gall stone.

Again, a calculus in the cystic duct may exert some slight pressure on the hepatic duct, and thus produce a very slight cholæmia.

It is a well-known fact that a diagnosis of gall stones is not infrequently made, and when the abdomen is opened they are not found. In some cases they may have already passed through into the intestine, but frequently the obstruction may arise from sharp curves or kinks in the common bile duct, the result of displacement of liver or duodenum, or from the presence of tumors, foreign bodies, or a hard plug of mucus in the ampulla of Vater. The pressure of displaced neighboring organs may be a cause of obstruction.

The diagnosis from intrahepatic disease is often difficult. In the latter condition there is always a certain quantity of bile which passes into the intestine, whereas if the gall stone closes the common bile duct completely, no biliverdin is found in the alvine evacuations.

The diagnosis between gall-stone disease and hepatic carcinoma is given under the latter head.

Prognosis.—The severity of the pain is not of prognostic value. Its gradual subsidence is often the forerunner of a fatal result, as the gall stones may be expelled through the wall of the gall bladder or ducts. A sudden cessation of pain is therefore a more favorable sign. The severity of the pain and the shock which accompanies it have been known to cause death in some cases.

The prognosis in cases of more or less permanent arrest, although

sometimes grave, is, as a general rule, favorable, and has been much improved since the recent developments of hepatic surgery.

Treatment.—*Prophylaxis.*—Although the chemical changes which take place in the formation of gall stones may be somewhat difficult to understand, we have a fairly clear idea of the predisposing conditions. Habits of living whereby the waste products are increased in the system and the secretions rendered abnormally acid, such as too much rich food and too little exercise, should be avoided. It has been sometimes noticed that gall stones form after elderly people have retired from a very active life. A moderate diet, with a lessened amount of saccharine and starchy food; regular exercise, sufficient to promote metabolism, and at the same time of a character which improves the circulation of the liver, would be indicated. Horseback and bicycle exercise are especially to be commended. The habit of taking deep inspirations and the abandonment of corsets should be enjoined. The avoidance of articles of diet rich in cholesterin, as brain, yelk of egg, etc., may also be necessary. Stimulants, as ale, porter, and port wine, are to be interdicted. Eichhorst recommends salicylic acid, 15 grains daily, as a preventive, and Schiff has spoken favorably of cholate of soda for the same purpose. The sulphate or the phosphate of soda in doses of from one to two drachms has been found useful. The drinking of water an hour before meals is often of service, on account of its action in flushing the liver.

Much difference of opinion has arisen as to the value of internal remedies in the treatment of gall stones. Germain Sée and Rosenberg recommend olive oil, whereas Meyer and Ewald regard it as useless. In the writer's experience large doses of olive oil have had a very beneficial effect in some cases. Care should be taken in its administration that a pure article is obtained, as the olive oil of commerce frequently contains impurities of an irritant character and an enteritis may thus be produced. A wineglassful may be given at bedtime every night. Glycerin may be given to those who cannot take olive oil.

Sodium salicylate increases the flow of bile, and appears to have a decided effect in causing the jaundice to disappear in some cases.

In some the irritability of the stomach requires attention. Small pieces of ice, champagne, and effervescing drinks may be given. Cardiac stimulants may be necessary when there is much heart weakness.

A French writer has recommended a course of treatment beginning with the administration of a full dose of calomel, followed by salol and salicylate of soda. It is not claimed that any of these remedies act as solvents of the calculi, but an increased flow of bile of less density has a decidedly beneficial effect, especially in those cases which are complicated by inflammation of the biliary ducts.

Sulphuric ether and chloroform have been given for the purpose of dissolving the calculi. The ready solubility of cholesterin in chloroform suggested this form of treatment. The once favorite Durande remedy was made up of three parts of sulphuric ether and two parts of oil of turpentine. This, however, proved irritating to the stomach, although it seemed to exercise a beneficial effect. Durande gave a drachm each morning, but twenty drops three times a day is more readily tolerated by the stomach. This remedy, as well as chloroform, probably acted as an antispasmodic rather than as a solvent of the calculi. Choleic-

acid salts—for instance, the cholate of soda—have been recommended by Schiff. Alkaline mineral waters seem to exercise a beneficial effect in cholelithiasis, although we are not able to explain their mode of action. Carlsbad and Vichy have been specially extolled in this particular. Water alone, when taken frequently and in large quantities, has a beneficial effect. The importance of overcoming the spasmodic contraction of the duodenal outlet to the ampulla of Vater, the choledoch sphincter, has recently been referred to by Leichtenstern. It is possible that belladonna may exert its influence locally in overcoming this contraction; and the beneficial effect of that drug may be, to some extent, due to this as well as to its general action. Succinate of sodium has been recommended by Tyson, and succinate of iron has also been used.

The absence of bile in the intestine causes indigestion, which is distressing and tends to malnutrition. To remedy this, ox-gall pills or the cholate of soda may be given. Vegetable acids, acetic and citric, have been recommended by Bouchard.

Harley emphasizes the presence of a dense liquid and a tendency to inspissation of the bile which he thought predisposed to the formation of calculi. The fact that bile is sometimes thick and dense, and at other times thin and watery, has been made quite evident in observing the secretion as it flows through a biliary fistula. For this condition Harley recommends the administration of from one to two drachms of the sulphate of soda in a bitter infusion before breakfast, and from twenty to thirty grains of bicarbonate of sodium at bedtime.

For the severe pain of hepatic colic a hypodermic injection of one fourth of a grain of morphine may be given, and repeated if necessary. Often chloroform may be indicated if moderate doses of morphine fail. Hot baths and hot local applications give more or less relief.

Prout recommended the giving of large quantities of hot water to which one or two drachms of the bicarbonate of sodium to the pint had been added. He thought that by its warmth it had a good effect even when it did not remain on the stomach. Murchison gave belladonna together with the morphine.

Hepatic Surgery.—Mayo Robson has given the following indications for operation: First, in frequently recurring hepatic colic, without jaundice and with or without enlargement of the liver; second, in enlargement of the gall bladder without jaundice, even if unaccompanied by great pain; third, in persistent jaundice ushered in by pain, and when recurring pains, with or without ague-like paroxysms, render it probable that the cause is a gall stone in the common bile duct. When there are a series of attacks and the presence of bile pigment in the urine or jaundice of the skin is an evidence that the calculus has not passed through the duct, an early operation is desirable. A perihepatic inflammation may render the operation much more difficult, and when jaundice is present a hemorrhagic condition may supervene which will militate very much against surgical interference. According to Naunyn, in 173 cases without jaundice death followed operation in 9.6 per cent., whereas in 70 cases with jaundice death took place in 48.7 per cent. after operation.

The following operations have been practised in certain cases: cholecystotomy, opening the gall bladder, and after removing the stones

stitching it to the wall of the abdomen; cholecystectomy, a complete removal of the gall bladder; cholecystenterostomy, making a direct opening from the gall bladder into the intestine; choledochotomy and choledochlithectomy, or the direct opening of the common bile duct and the removal of the calculus. The comparative merits of cholecystotomy and cholecystectomy have been freely discussed by hepatic surgeons. The argument in favor of cholecystotomy is that it is not so formidable an operation as the removal of the gall bladder. The advantage for cholecystectomy arises from the fact that the gall stones generally form in the gall bladder, and when the latter is removed their formation is not so likely to recur.

In cholecystotomy the gall bladder may be first sutured to the walls of the abdomen and an immediate incision made, or after the abdomen is opened an incision may be made into the viscus, the contents removed, and the walls sutured to those of the abdomen.

Besides these, the following operations have been reported: Simple puncture or incision of the gall bladder made after opening the abdomen. This operation may be done when the gall bladder is adherent to the parietal peritoneum.

Cholecystendysis, incision into the gall bladder, removal of the contents, and restoration of the incised wall after suture. The gall bladder is returned to the abdominal cavity.

Choledochlithotrity, the crushing of a gall stone in the common bile duct.

In some cases the calculus has been expelled from the common bile duct by pressure from without.

Mayo Robson is of opinion that, excluding cases of malignant disease, the mortality of operations for the removal of gall stones ought not to exceed 5 per cent. In 39 cases operated on by Riedel a complete cure was made in about 90 per cent.; 19 out of 21 cases in which jaundice was absent were cured; in 1 a biliary fistula removed, and 1 died after extirpation of the gall bladder. Of the 18 patients with jaundice, in 15 a cure was reported, and 3 died.

The successful treatment of gall-stone disease by surgical methods is therefore thoroughly established.

NARROWING AND OCCLUSION OF THE BILIARY CANALS.

The conditions causing stenosis may be placed under three heads: (1) those existing in the lumen; (2) those in the walls; and (3) those external to the bile ducts, causing pressure from without.

(1) Causes within the Lumen.—(*a*) Of the causes within the lumen, *gall stones* are altogether the most frequent. They are usually found in the cystic or at the duodenal end of the common bile duct, although they may exist anywhere throughout the course of the latter.

(*b*) *Parasites.*—Of these the echinococcus is the most frequent. A ruptured cyst may empty part of its contents into the biliary passages, and the occlusion may be temporary, the cyst passing through with the ordinary symptoms of hepatic colic. In the case of multilocular cyst

the obstruction will probably be permanent. Liver flukes and round-worms have also been known to cause obstruction.

(*c*) *Foreign bodies* occasionally pass into the common bile duct from the duodenum. In the normal state the opening is so small that this accident does not often happen. In some cases the tube is dilated by the passage of a gall stone, and then substances such as cherry stones, seeds, etc. may enter it.

(2) Lesions in the Walls of the Bile Ducts.—(*a*) Complete occlusion may result from an *ulcer* in the walls produced by biliary calculi. Ulceration sometimes occurs in severe infectious diseases, as typhoid fever. Von Schüppel is of the opinion that severe catarrhal inflammation may lead to granulations and adhesions.

(*b*) The orifice of the common bile duct may be closed by the cicatrization of a *duodenal ulcer*.

(*c*) *Tumors* growing from the wall or from the duodenum at the end of the common bile duct may cause partial or complete obstruction.

(*d*) *Strictures* of the bile ducts somewhat similar to urethral stricture have been recorded. They are one or two inches in length, and sometimes arise from the cicatrization of an ulcer.

An increase of the fibrous structure in the walls of the ducts may be due to severe catarrhal inflammation or to the extension of perihepatitis. The cystic duct is often occluded by inflammation extending from the gall bladder. The hepatic duct is not so frequently obstructed, but it may be the seat of pigmentary calculi.

Cases of congenital occlusion of the biliary passages have been reported.

(3) Tumors External to the Biliary Passages.—These cause narrowing or complete occlusion by external pressure and by adhesions of the vessel walls. The carcinomata are the most frequent, and they grow more rapidly than the others, not only causing pressure, but invading the wall and the lumen of the vessel. Cancerous tumors of the pylorus, of the duodenum, as well as of the head of the pancreas, may invade the common bile duct. Enlarged lymphatic glands in the portal fissure act in the same way. The glandular enlargement is generally of a cancerous nature, but may arise from tuberculosis or leucocythæmia.

Aneurysm of the hepatic artery has caused jaundice by pressure, and a case of aneurysm of the superior mesenteric artery has been reported by Gairdner which produced the same result. Aneurysm of the abdominal aorta has rarely caused jaundice.

Other causes of obstruction by pressure from without are—impacted fæces in the colon, the enlargement of the uterus in the later stages of pregnancy, ovarian tumor, and tumor of the right kidney. The changes which take place in the bile ducts above the obstruction have been already described.

The formation of cysts from local dilatations might be here referred to. These are sometimes numerous, and vary in size from that of a pea to that of a child's head. The cyst wall is covered sometimes with pavement and sometimes with cylindrical-celled epithelium.

Diagnosis.—It is often impossible to differentiate these various conditions from one another, but in some cases we are able by careful study to arrive at a fairly correct conclusion. Congenital stenosis may

be suspected when the jaundice in a newly-born infant lasts longer than two weeks. It comes on two or three days after birth, and gradually increases in intensity and is accompanied by vomiting and hemorrhage with emaciation. The fecal discharges show an absence of biliary matter.

Permanent *occlusion by gall stones* is the condition most frequently found. This is preceded by the symptoms of biliary colic, severe pain accompanied by jaundice, and the presence of tenderness in the subhepatic region. Some elevation of temperature and rapidity of the pulse will also be noticed. On physical examination an elastic tumor may be felt if the gall bladder is distended.

Occlusion by Parasites.—In the case of hydatids the presence of an elastic tumor may be made out, with the peculiar hydatid fremitus. The remains of a hydatid cyst may be discovered in the fæces. In other respects the symptoms may resemble those of biliary colic.

Catarrhal jaundice sometimes occurs in children when round-worms are present in the intestinal canal. The cholangitis may be continuous with catarrhal duodenitis.

When the attack comes on suddenly, perhaps with a convulsion, the presence of a round-worm may be suspected if no other probable cause is apparent.

The stenosis of the biliary passages from *ulceration* and *cicatrization* is generally preceded by the history of gall stones. Typhoid fever and other severe infectious diseases are not often the cause of ulceration.

Closure of the duodenal end of the ductus communis choledochus by the cicatrization of an ulcer would be preceded by the symptoms of duodenal ulcer—pain some time after eating, intestinal hemorrhage, etc. When rapid and marked emaciation follows biliary obstruction, one is led to suspect the involvement of the pancreatic duct as well.

The differentiation between the various tumors which might cause pressure is given on page 561.

Treatment.—The treatment of permanent stenosis of the biliary passages lies in the domain of surgery rather than of medicine. Cholecystotomy and, better still, cholecyst-duodenostomy have been successfully performed, and cases which were formerly considered hopeless have been permanently cured. The urgency for an operation will depend on whether symptoms of inflammation and suppuration are present or not. The management of cases previous to and after an operation is of great importance. The diet should consist of milk, eggs, meat broths, and lean meat. Indigestible and fatty food, as well as alcohol, should be interdicted. Moderate doses of calomel, followed by salines and the administration of salol and salicylate of soda, may be necessary. (Further details of treatment are given under the head of Obstructive Jaundice, p. 435.)

HEMORRHAGE INTO THE BILIARY PASSAGES.

According to Von Schüppel, large extravasations of blood into the bile ducts are of comparatively rare occurrence.

Etiology.—Some constitutional diseases, as yellow fever, acute yellow atrophy, and purpura hæmorrhagica, may cause the lesion. Budd

reported 1 case of hemorrhage from ulceration of the gall bladder in a boy seventeen years of age. A communication between the biliary passages and a large vessel—for instance, the rupture of an aneurysm of the hepatic artery into the common bile duct—has been reported. Rupture from falls, communication the result of abscesses opening into both sets of vessels, and carcinomatous disease are also causes of hemorrhage. In some cases of cardiac liver the biliary passages and gall bladder have been found filled with liquid blood, probably the result of diapedesis. M. H. Claude has reported 7 cases of hemorrhage of the gall bladder in rabbits killed by microbic toxins. He argues from this that similar hemorrhage may take place in human beings in such diseases as typhoid fever, and that the coagulum may afterward form the nucleus of a gall stone.

Diagnosis.—The diagnosis of hemorrhage of this character may be quite impossible. In some cases the predisposing condition may be discovered when the sudden anæmia and the appearance of blood in the fecal discharges lead one to suspect a hemorrhage into the biliary passages. Dilatation of the gall bladder, with pain in the hepatic region and symptoms similar to those of hepatic colic, may be present.

DILATATION OF THE GALL BLADDER.

Although this condition has been referred to already, it is of such importance from a clinical standpoint that a special reference to it would seem necessary.

The diagnosis, which is sometimes difficult, is often of great moment, as the proper surgical treatment so necessary to the welfare of the patient depends upon it.

Etiology.—In addition to the causes already mentioned under the head of Stenosis of the Biliary Passages, dilatation of the gall bladder may arise from paralysis of the walls without any obstruction being present. Occasionally a spasmodic stricture of the cystic duct has been said to produce temporary distention of the gall bladder. In catarrhal cholecystitis the mucous membrane of the cystic duct may become swollen and obstruction be produced in that way.

Pathology.—When the bile can neither enter nor leave the gall bladder it gradually disappears and the cavity becomes filled with a mucous and a sero-mucous fluid. The serum is transuded from the bloodvessels of the cyst wall, and may accumulate so as to produce great distention of the gall bladder. If pyogenic organisms find their way into the gall bladder, the contents become purulent and a suppurative cholecystitis results. When the distention is not great the contents may become absorbed and atrophy follow.

Pathological Anatomy.—The distended gall bladder may contain bile, bile-stained mucus, sero-mucus, or pus. The walls may be much thickened and congested ; ulceration is often found and perforation occasionally takes place. The mucous membrane in one case of suppurative cholecystitis seen by the writer was almost completely separated from the subjacent structures. Harley has reported a case of

carbonate-of-lime deposit around the inner side of the cavity of the gall bladder.

Symptoms.—Physical examination will reveal the presence of an elastic tumor varying in size, pyriform in shape, and found in the ordinary situation of the gall bladder. Peculiarities in size, shape, and position have been noticed. The situation may be changed with change in the shape and position of the liver. It may be felt near the median line in the right flank or in the right iliac region. In a case recently observed by the writer the tumor, about twice the size of a normal kidney, was found in the right lumbar and iliac regions. The liver was enlarged and somewhat drawn down by the weight of the distended sac. When operated on by Dr. Temple a distended gall bladder with mucopurulent contents was found. It was opened and drained, and the patient made a good recovery. The size of a distended gall bladder varies much, and may reach that of a child's head. The gall bladder is usually pyriform, but is often elongated and sausage-shaped. A case of this kind was seen by the writer two years ago. The patient, a young married woman, had suffered for some years from a severe pain in the hepatic region without jaundice. The attacks occurred at intervals of a few weeks and seemed to be brought on by over-exertion. A tumor was found about one and a half inches below the liver margin and at the outer border of the right rectus muscle, round and circumscribed, not unlike that of a hernia. A tympanitic note which extended up to the hepatic margin was elicited on percussion. The surface was tender, and the patient suffered from symptoms of moderate fever. Dr. Ross operated and found a distended gall bladder, sausage-shaped, about four inches in length, with a sharp-pointed extremity. It extended downward and forward from the under surface of the liver, so that the extremity was about two inches below the anterior margin. The sharp point pressed against the abdominal walls, so as to cause some atrophy, and the distended bowels produced the tympanitic resonance. When the cyst was opened the walls were found much thickened, and it was filled with slightly greenish mucus, and gall stones were discovered obstructing the cystic duct.

Cases sometimes occur in which, owing to changes in the position of the liver or of the surrounding parts, the distended gall bladder may not come in contact with the anterior walls of the abdomen, and cannot possibly be felt

The constitutional symptoms vary with the cause of the distention. If biliary calculi obstruct the duct, symptoms peculiar to cholelithiasis may be present. In any case a feeling of tension and greater or less pain will be experienced in the hepatic region. In cases of suppurative cholecystitis symptoms of pyæmia, chills followed by fever, may be present. When a rupture takes place the signs of collapse become manifest, followed by those of general peritonitis.

Diagnosis.—The diagnosis of dilated gall bladder is in many cases not easily made. The principal points are the previous history of gall stones or of other forms of obstruction, and the presence of an elastic pyriform tumor in the region of the gall bladder, which is tender on pressure. Jaundice may or may not be present. Sometimes a fremitus is noticed from friction of calculi in the cyst, and the size of the tumor seems to

change when there is a greater or less amount of flatulence in the bowels. The connection of the tumor with the liver may be demonstrated by its moving with the movements of the diaphragm in respiration. This is not conclusive, for when the liver is much enlarged and there is great distention of the gall bladder, there may be little or no movement on even deep respiration. A very important diagnostic point is the fact that when the tumor can be moved about in the abdomen it is noticed that the upper extremity is fixed and the lower is freely movable. The diagnosis from cystic floating kidney will sometimes be made in this way.

The conditions for which dilated gall bladder has been mistaken are ascites, cystic tumor of the ovary, hydronephrosis, hydatid cyst, and a tongue-like prolongation of part of the right lobe of the liver. The differentiation of ascites should not present any very great difficulty if a careful examination is made. The shape of the abdomen and the change in position of the fluid when the patient moves from side to side should be conclusive. Cystic tumors springing from the pelvis can be differentiated by the dulness being continued downward and by the history of a tumor growing from below upward.

Hydro- and pyonephrosis of the right kidney present greater difficulties, especially if the organ should be at the same time displaced. The absence of dulness in the normal kidney area, the shape of the tumor, and the presence of pus in the urine may aid in the diagnosis. The situation of the ascending colon with regard to the tumor is often an aid to diagnosis. The colon is usually found more or less anterior to the cystic kidney, and posterior to a distended gall bladder. In some cases by means of bimanual palpation the physician will be enabled to differentiate between the two conditions. When the patient is in the recumbent posture and pressure is made in the lumbar region forward and upward, a distinct impulse will be felt over the anterior surface of the abdomen when a floating cystic kidney is present. A displaced kidney situated posterior to a distended gall bladder, and adherent to it, will give the same signs. In such cases by deep palpation the one can sometimes be distinguished from the other. Sometimes a distended gall bladder may occur in a patient whose right kidney is displaced, thus increasing the difficulty of differentiation. Carcinoma of the gall bladder may be excluded by the history, cachexia, and emaciation, and by the presence of a hard, nodular growth in the gall bladder region. It must be remembered that the walls of a distended gall bladder may be so thickened that it may be hard and seem nodular. On the other hand, in cases of carcinoma the gall bladder is distended more frequently than in cholelithiasis.

It may not be easy to say whether the distended gall bladder contains bile, mucus, or pus. When jaundice accompanies obstruction bile will probably be found. When there is a history of biliary colic without jaundice the cyst will contain mucus. If there are symptoms of suppuration, fever, chills, high temperature, and sweating, a suppurative cholecystitis will probably be found.

Cases have been described in which the gall bladder was distended with bile when there was no jaundice. The obstruction in the cystic duct may allow bile to flow in, but not to leave the gall bladder. In

some cases of suppurative or ulcerative cholecystitis the case may not come under observation until after rupture takes place. Symptoms of collapse and of the presence of fluid in the abdomen, with those of general peritonitis, may follow, and if the history reveals the former occurrence of symptoms of cholelithiasis, a probable diagnosis may be made.

TREATMENT.—The treatment of cases of distended gall bladder now comes under the domain of surgery, therefore the indications for operation and the general management only will be considered here.

The patient should remain in bed. As a general rule, the pain and discomfort from moving about will cause the patient to keep quiet. The pain may to some extent be relieved by hot applications. Saline laxatives and intestinal antiseptics may be necessary on account of the fluctuation.

If, together with the ordinary signs of distended gall bladder, there are also symptoms of suppurative fever, an operation should not be delayed, as rupture might at any time take place. In any case, when the diagnosis is made an early operation affords the only hope of a permanent cure.

ATROPHY OF THE GALL BLADDER.

THIS sometimes results from catarrhal inflammation in the course of cholelithiasis and sometimes in carcinoma. The cavity may be completely obliterated by the new growth.

Cases of congenital absence of the gall bladder have been noticed.

DISEASES OF THE SPLEEN.

DISEASES OF THE SPLEEN.

DISEASES OF THE SPLEEN.

By GEORGE ROE LOCKWOOD, M. D.

PHYSICAL DIAGNOSIS OF THE SPLEEN.

Position.—The spleen lies in the left hypochondrium, between the ninth and eleventh ribs, with its longest diameter passing forward and downward parallel to the course of these ribs. The upper and posterior third is covered by the left lung. The lower margin touches the convex border of the left kidney. The anterior edge of the normal spleen does not usually pass beyond a line drawn from the left sterno-clavicular articulation to the tip of the eleventh rib (*linea costo-articularis*), although it may rest upon this line, and at times during deep inspiration it may even pass 1 cm. beyond this limit.

According to Leichtenstein, the splenic area varies according to the thoracic circumference. When the thorax is capacious and of large girth, the anterior end of the spleen usually lies behind the mid-axillary line. On the other hand, should the thorax be of small circumference, the anterior margin is usually found at or beyond this limitation.

The convex upper border lying parallel to the ninth rib crosses the lower boundary of the left lung at a point known as the spleno-pulmonary angle. This angle is usually found in the diagonal position at the eighth interspace or the ninth rib in the mid-axillary line. In the spleno-pulmonary angle are to be found the splenic flexure of the colon and the fundus of the stomach. The lower border of the spleen and the outer border of the left kidney form the spleno-renal angle, in which lies the descending colon.

Inspection.—Inspection gives negative results unless the spleen be very considerably enlarged. Sufficient enlargement may cause a projection of the left hypochondrium extending forward and downward into the anterior regions of the abdomen. If the abdominal walls are lax, the border of the enlarged organ may be distinctly seen and any surface irregularities discovered. If the upper border of the spleen be still in apposition to the diaphragm, inspiratory sinking is plainly visible.

Palpation.—Palpation is by far the most valuable method of examination, because the results obtained by it are much more certain than is the case with percussion. With a moderate amount of experience small degrees of splenic enlargement may be accurately determined.

The patient, lying upon the right side or in the diagonal position (*i. e.* lying on the right shoulder midway between the dorsal and lateral decubitus) with the knees drawn up, is instructed to relax the abdominal muscles as completely as possible and to take long deep inspirations. The examiner, standing with his back toward the patient's head, applies the palm of the left hand against the posterior portion of the splenic region and pushes firmly forward, while with the fingers of the right hand the abdominal wall is gently invaginated under the costal arch at about the tip of the tenth rib. If the spleen be moderately enlarged, the anterior edge may be felt to strike the finger-tips as the organ descends during deep inspiration. Obesity and rigidity of the abdominal wall render this method of examination difficult or even impossible.

Leichtenstein has drawn attention to the fact that not infrequently the costal serrations of the diaphragm which interlock with the serrations of the transversalis abdominalis muscle may be felt in their contracted condition, giving to the finger the impression of a rounded point which may readily be mistaken by the inexperienced examiner for the anterior edge of the spleen. Among other sources of error may be mentioned irregular muscular contractions of the abdominal muscles induced by rough manipulation, and new growths or irregular deposits of fat in the abdominal wall. A simple increase of resistance at the edge of the ribs during inspiration cannot be referred to the spleen unless other corroborative signs of splenic enlargement are present. When the spleen is much enlarged, so that the anterior edge presents itself beyond the free border of the ribs, the examination may be made by preference in the dorsal position.

The anterior border of the spleen may be appreciated by palpation in individual cases during health when the abdominal wall is very lax, and also in those with deformed chest. The organ, even if of normal size, may also be detected if it be displaced with a low position of the diaphragm or if the condition of "wandering" spleen be present.

In patients with aortic regurgitation distinct systolic pulsations may be appreciable if the spleen be sufficiently enlarged to present itself beyond the costal arch.

In cases of great enlargement the notches of the upper border can be distinctly felt, and are fairly characteristic of the splenic origin of the growth.

The presence of tenderness, the degree of consistence, the form and character of the surface, and the degree of mobility of the organ are points also to be elicited by manual palpation.

Fluctuation and hydatid fremitus are also signs that if present are of the utmost value in diagnosis.

Percussion.—The position of the patient during the examination is of great importance. The back, right side, diagonal, face, and standing positions have each been endorsed by leading clinicians. The diagonal posture is generally accepted, however, as the most favorable. In this posture the patient lies on the right shoulder, reclining thus midway between the dorsal and right-sided decubitus. The disadvantage of the right lateral position is that the determination of the lower border of the spleen is rendered difficult or even impossible by the approximation of the lower ribs and the crest of the ilium. The upright position is

at times serviceable, and, according to Weil, is of equal value with the diagonal decubitus.

For the percussion of the spleen Weil's method is to be advised. The patient lying in the right diagonal position, light percussion is to be made vertically downward from about the sixth rib in the scapular, axillary, and mammary lines until the full clear note of pulmonary resonance passes into an empty or dull sound, thus determining the lower boundary of the lung. In the diagonal position the lower limit of the left lung is usually at the seventh rib in the mammary line, the eighth rib in the mid-axillary line, and the eleventh rib in the scapular line. The determination of the lower border of the lung can readily be made if the transition from the pulmonary resonance to the gastric tympanitic sound is not too indistinct.

After the lower margin of the lung is determined, percussion is to be carried downward in the axillary line until the deadened note of splenic dulness is repeated by a clear tympanitic (intestinal) note, thus determining the lower boundary of the spleen. This lower border cannot be traced farther back than the posterior axillary line, as the percussion note from the lung downward beyond this line is uniformly dull.

To obtain the anterior limit of splenic dulness light percussion is to be carried from the semilunar space and from the abdomen in lines converging to the supposed centre of splenic dulness, marking the points at which intestinal or gastric tympany changes to splenic dulness. By connecting these points and borders an outline is obtained corresponding to that portion of the spleen uncovered by lung.

It is evident that percussion can only approximate the actual size of the spleen, as no evidence is afforded as to the size of the area overlapped by lung. Practically, the size of the spleen is estimated by the vertical height of splenic dulness and by the position of the anterior border.

The average dimensions in health, according to Weil, have been found as follows:

In the diagonal position the height of splenic dulness is 5.5 to 7 cm., the anterior edge reaching at most to the linea costo-articularis.

In the upright position the height is 4.5 to 6 cm., the anterior edge under some circumstances passing a little beyond the linea costo-articularis.

Enlargement of the spleen, according to Vierordt, is to be assumed by percussion alone only when the vertical measurement of dulness is 9 cm. or more, if the area of dulness extend beyond the linea costo-articularis, or if the dulness be very decided, passing into flatness with strong percussion.

Difficulties of Percussion.—I. *The area of splenic dulness may be smaller than the actual size of the spleen under the following conditions:*

a. Flatulent distention of the stomach or colon, especially if the spleen be flat and disk-like, may render the results of percussion extremely deceptive. A condition is even possible in which both the anterior and posterior border and the anterior extremity of the spleen are surrounded by a distended colon. The whole of the splenopulmonary angle may be occupied by a flatulent stomach.

b. The spleen may be overlapped by emphysematous lung.

c. The anterior edge of the spleen may be so thin that the tympany of the underlying structures is transmitted through it.

d. The spleen may be displaced upward when the diaphragm is high, as after the retraction of the pleura that follows empyema or when there is great increase in the abdominal contents by flatulence, ascites, or tumors.

II. *The area of splenic dulness may be larger than the actual size of the spleen under the following conditions:*

a. Solid or fluid accumulations within the stomach or colon, yielding dulness which is continuous with that of the splenic area. Hence in cases in which an accurate diagnosis is indicated the examination should be made after a period of abstinence from food and drink and after free purgation.

b. Emphysema and any increase in the thoracic contents, displacing the spleen downward.

c. Consolidation of the lung or pleural accumulations, increasing the apparent area of splenic dulness upward.

d. Growths of left kidney, increasing the apparent area of splenic dulness downward.

e. Enlargement of the left lobe of the liver, growths of the fundus of the stomach or colon, abundance of fat in the great omentum, and encapsulated peritoneal exudations, increasing the apparent area of splenic dulness forward.

f. Retraction of the left lung, exposing areas of the spleen that would otherwise be covered by pulmonary tissue, and thus increasing the height of splenic dulness.

Auscultation.—In cases of perisplenitis auscultation enables us to detect peritoneal friction sounds, provided that the diaphragm is not paralyzed and that the spleen has not become actually adherent. In a small number of enlarged spleens, especially if they are at the same time movable, a systolic murmur may be heard over the situation of the hilus of the organ. Testi attributes the murmur in the majority of cases to torsion of the afferent vessels, producing a partial stenosis of the splenic artery. A systolic murmur may be also heard over the spleen in well-marked cases of aortic regurgitation.

ACUTE HYPERÆMIA.

Etiology.—Aside from the physiological hyperæmia that occurs at the height of intestinal digestion, acute hyperæmia of the spleen occurs as a secondary process in a large number of acute infectious diseases, and appears to be due to the direct action of bacterial toxins upon the spleen tissue. The hyperæmia is especially well marked with typhoid fever, pneumonia, diphtheria, pyæmia, and the acute exanthemata.

Acute hyperæmia is also caused by contusions and traumatisms of the spleen, associated frequently with small parenchymatous hemorrhages, while in some instances the cellular proliferation that characterizes acute hyperplastic inflammation is present.

Pathological Anatomy.—The spleen is regularly increased in size, although rarely more than to a moderate extent. The pulp on section of the organ is dark and soft, projecting from the cut surface so as to conceal entirely all traces of the trabecular structure. The cavernous veins show considerable distention with blood, and a quantity of red and white blood cells are usually found in the interstices of the pulp.

Owing to the peculiar distribution of blood in the organ, it is often difficult, and at times impossible, to distinguish between hyperæmia and moderate interstitial or parenchymatous hemorrhages, especially in traumatic cases, in which both hyperæmia and small hemorrhages are usually combined.

Acute hyperæmia alone, however, is, strictly speaking, rather a rare condition, as in the vast majority of instances there is added a proliferation of the pulp cells, so that the congestion is combined with a hyperplastic inflammation. As acute hyperæmia, moreover, tends to pass into acute hyperplastic splenitis, there is no strict line of demarkation to be drawn between the two conditions, and it is often difficult in any given case to determine under which category to place the lesions presented.

Symptoms.—The symptoms are usually those due entirely to the primary disease. Subjective symptoms on the part of the spleen are usually wanting.

Physical examination reveals slight enlargement of the organ ; rarely, however, does the anterior side project more than 2–3 cm. beyond the free border of the ribs. Considerable tenderness may be elicited by palpation.

Treatment is to be directed toward the primary disease.

PASSIVE CONGESTION.

Etiology.—Owing to the peculiarities of the splenic circulation, whereby the blood is poured directly into the spleen pulp under conditions which render it extremely liable to stagnation, passive congestion of the organ is readily permitted whenever the free outflow of blood through the splenic vein becomes in any way impeded.

Acute passive congestion occurs occasionally with those circulatory and respiratory disturbances which lead to general venous congestions. But by far the commonest cause is found in some obstruction to the flow of blood through the portal vein, so that acute congestion of the spleen may be traced to some such condition as cirrhosis, pylephlebitis, external pressure on the portal vein, or to the contraction of peritoneal adhesions.

Chronic congestion may succeed acute congestion or the condition may be chronic from the start. Besides portal obstruction, cardiac insufficiency and emphysema of the lungs as etiological factors, chronic infectious diseases, such as malarial poisoning and syphilis, may be cited as causes for the congestion of the organ, although in these chronic infections the splenic condition usually oversteps the limits of simple congestion and passes into the state of chronic indurative splenitis.

Pathological Anatomy.—Venous congestion of the spleen may exist, within certain limits, without structural alteration of the organ. In more advanced stages the spleen is enlarged, but only to a moderate extent: the capsule is tense; upon section the pulp is either soft or firm, and is usually dark red in color, although the color may not be darker than normal. To explain the latter variation in the coloration of the pulp, Nicolaides surmised endarteritis, and Rindfleisch an increase in the contractility of the small arteries by hypertrophy of the muscular tissue of their walls.

After the process has lasted a considerable time there is added a chronic interstitial splenitis, as evidenced by the thickening of the trabeculæ and of the reticular framework of the organ. To this condition the term "cyanotic induration" is frequently applied, although "chronic indurative splenitis" would seem to be preferable.

Symptoms.—Subjective symptoms may be entirely lacking. Occasionally patients complain of a sense of weight and pressure in the left hypochondrium, which is increased by motion, coughing, or straining. There may be pain referred to the spleen or radiating to the left arm or leg. These subjective disturbances are usually increased whenever the patient lies on the left side, but occasionally the right lateral decubitus is more uncomfortable, owing to the stretching of the splenic ligaments thus made tense by the weight of the enlarged viscus.

Pressure symptoms may occur if the spleen be sufficiently enlarged: of these dyspnœa and disturbances of the heart's action are the most prominent; gastric symptoms and irregularity of the bowels may also occur.

The symptoms due to congestion of the spleen are usually much relieved whenever the portal circulation becomes depleted by cathartics or by hemorrhages from the gastro-intestinal tract.

Physical Signs.—Decided enlargement will usually be recognized without difficulty. The physical signs are identical with those of acute hyperplastic splenitis, so that a diagnosis cannot be made by objective signs alone.

Treatment is to be directed toward the primary disease.

ACUTE HYPERPLASTIC SPLENITIS (ACUTE DEGENERATION OF THE SPLEEN).

Etiology.—Acute hyperplastic splenitis is due to the same causes as acute hyperæmia, and may develop from it, or the two conditions may coexist from the very first. The process is regularly secondary to some acute infection, and the lesion appears to be due to the action of bacterial toxins upon the spleen tissue, the process being pathologically identical with the acute degeneration of the kidneys and liver so commonly encountered in acute infections, except that, owing to the more abundant blood supply of the spleen, congestion assumes a more important share in the process.

Pathological Anatomy.—The spleen is regularly increased in

size, often to a considerable degree ; enlargements to twice or three times the normal size are not infrequently encountered. The pulp is usually of a dark red color, although it may be reddish gray or mottled gray and red ; it is of softened consistency, and projects from the cut surface so as to obscure the trabeculæ. The glomeruli are, however, usually prominent.

Microscopical examination shows the enlargement to be due both to the hyperæmia and to the swelling and proliferation of the cells of the pulp or of the glomeruli, or of both. In some instances the hyperplasia of the glomeruli seems to be the prominent feature. The pulp cells are almost regularly increased in size and number, and show multiplication of their nuclei. Many of the cells are seen in a condition of fatty degeneration. Large cells are often found containing within them structures which resemble red blood cells or their fragments.

Small necrotic areas may be seen in some cases, often associated with localized suppuration, and may be due to infectious embolism of small twigs of the splenic artery. This is most constantly seen in the spleen of relapsing fever, in which disease small areas of necrosis and suppuration, rarely larger than a pinhead in size, are frequently found within the follicular tissue in such abundance that the dark background appears to be sprinkled with them : they may be limited to a comparatively small section of the organ corresponding to the distribution of some particular branch of the splenic artery or they may be more generally distributed. Besides these follicular abscesses in the spleen of relapsing fever, infarcted areas, frequently of very large size, without arterial occlusion, are encountered in a large percentage of cases. (For the detailed description of the splenic lesions of relapsing fever the reader is referred to the article on that disease, Vol. I. p. 259.)

Symptoms.—The symptoms are chiefly those of the primary disease. Hyperplastic splenitis may exist, even to a marked degree, without revealing its existence by symptoms. Patients, however, will often complain of a dull aching pain in the left hypochondrium, which may become lancinating at certain times and radiate to the back, the left shoulder, or the leg. Severe pain generally betokens a participation of the serous coat in the inflammatory process or such a degree of enlargement that the capsule becomes overstretched and the splenic ligaments are dragged upon by the increased weight of the organ. Tenderness on pressure or pain increased by motion, coughing, vomiting, or the right lateral decubitus, usually, but not invariably, indicates a complicating perisplenitis.

Physical examination reveals enlargement of the spleen, occasionally to such an extent that the anterior border nearly approaches the median line of the abdomen. Usually, however, the anterior border of the organ does not extend farther than 2–5 c.m. beyond the linea costo-articularis.

Prognosis is that of the exciting cause. After convalescence from specific fevers the spleen usually returns to its normal size, but in some cases the congestion may become chronic and the condition pass into that of chronic indurative splenitis : this is especially liable to happen in cases where the stimulus continues to exert an influence upon the spleen, as in chronic malarial poisoning.

Rupture of the spleen is a rare complication of acute splenitis, especially in the malarial cases of the tropics, but some degree of traumatism is usually necessary to induce the accident.

Treatment is to be directed toward the primary disease. Injections of ergotin, etc. into the splenic parenchyma for the purpose of reducing the size of the organ are hazardous in the extreme, and are, moreover, inefficacious.

CHRONIC INDURATIVE SPLENITIS.

Etiology.—This condition occurs as a localized process in the periphery of old infarctions and abscesses, and may thence extend to involve larger areas of spleen tissue. As a diffused process it may follow acute hyperplastic splenitis or long-continued passive congestion: to this latter condition the term "cyanotic induration" has been frequently applied.

Chronic indurative splenitis is most common with chronic malarial poisoning, constituting the condition known as "ague cake." It also occurs with inherited or acquired syphilis, with protracted typhoid fever, and with leucæmia and pseudoleucæmia.

Pathological Anatomy.—Although the organ may be found of normal size, it is usually much enlarged. Instances are not at all rare in which the anterior edge of the enlarged viscus passes the median line, especially in the leucæmic cases. The capsule is usually thickened, in some cases unevenly so. The cut surface may be of normal color or it may be gray, dark, purplish red, brown, or even black. These variations in the color seem to depend upon the relative degree of congestion, pigmentation, and connective-tissue hyperplasia.

Although the pathological processes are practically identical in all the cases, two varieties are met with which differ somewhat in the appearances presented. In one set of cases there is more or less uniform hyperplasia of both pulp and interstitial tissue. The pulp cells are increased in size and number, and the lining cells of the cavernous veins also show active proliferation. The reticulum of the pulp, the trabeculæ, and the glomeruli are more or less thickened by connective tissue. There is apt to be a deposit of pigment in the cells of the pulp or of the glomeruli or of the newly formed connective tissue. Upon section of the organ in the majority of instances the glomeruli are indistinct, and the trabecular structure is obscured by the swelling of the pulp. There may be a complicating chronic perisplenitis, or acute attacks of perisplenic inflammation may occur from time to time.

In another set of cases the trabecular thickening is the more important feature; the changes in the pulp are atrophic and secondary. The cut section of the spleen is traversed by an interlacing network of irregular connective-tissue bands, in the meshes of which the spleen pulp lies.

Between these two principal types are found a great variety of intermediate forms, combining, in varying degrees, the characteristics of each.

Symptoms.—The symptoms of chronic indurative splenitis are, in the main, those of the primary disease: symptoms induced directly by the splenic condition are usually lacking. If, however, the spleen be considerably enlarged, complaint may be made of a heavy dragging feeling referred to the left hypochondrium. Pain may be experienced from time to time over the splenic region, which may radiate to the arm or leg. Intensification of the pain by changes in the patient's position may occur, as in chronic congestion of the spleen.

Pressure symptoms, such as dyspnœa, disturbances of the heart's action, disorders of digestion, and irregularities in the action of the bowels, may occur if the spleen becomes sufficiently enlarged or if it become displaced from its normal position. If the increased weight of the spleen drag upon and stretch the splenic ligaments, the physical signs and symptoms of wandering spleen may appear. For the detailed description the reader is referred to the section on Wandering Spleen (p. 630).

Physical Signs.—The physical signs are those of enlargement of the spleen, often to a very considerable degree. The absence of marked pain and tenderness, of fever and septic symptoms, usually excludes abscess without much doubt, but if a complicating perisplenitis be present there may be great pain and tenderness over the organ and considerable elevation of temperature; so the diagnosis may be for a time one of extreme difficulty. An enlarged, indurated spleen with malarial fever may also be mistaken for splenic abscess, but the trial effects of quinine serve to clear up all doubts as to the real diagnosis of the case.

Treatment is to be directed toward the original disease. There have been a number of remedies recommended to act directly upon the enlarged spleen and to reduce its bulk. Among these may be mentioned the injection of carbolic acid or of tincture of iodine directly into the substance of the organ. In the light of present experience, however, these parenchymatous injections are not only inefficient, but should be regarded as positively contraindicated, because of the risk which they entail of hemorrhage and inflammation.

If the spleen be excessively enlarged, so as to cause urgent pressure symptoms, extirpation of the organ may be advised, provided that the case be not one of leucæmia. Removal of a leucocythæmic spleen almost constantly is followed by death, but in non-leucæmic cases splenectomy may usually be practised with safety.

ABSCESS OF THE SPLEEN (ACUTE SUPPURATIVE SPLENITIS).

Etiology.—By far the greatest number of suppurative infections of the spleen are of embolic origin. It is well known that the vascular arrangement of the spleen affords most favorable opportunities for the lodgement of emboli, and, in fact, embolic abscesses are not infrequent in the spleens of those who have died from septic diseases. Most commonly embolic abscesses accompany puerperal sepsis, malignant endocarditis, pyæmia, gangrene, or abscess of the lung. In rare instances

abscess follows hemorrhagic infarctions by a process of secondary infection, although the primary lesion may be aseptic in character.

Under the causal heading of septic embolism may probably be included abscesses of the spleen which arise during the course of typhoid, typhus fever, and Asiatic cholera. Abscess of the spleen complicates about 1 per cent. of cases of relapsing fever, occurring usually after the second recurrence.

The so-called "simple" or primary" abscesses, in distinction from those of embolic origin, are less frequent.

In rare instances the condition has followed wounds or contusions of the splenic region, and exposure to cold, especially when combined with severe and long-continued exertion, has also been cited as an exciting cause. Infection of the spleen may occur by the direct extension of inflammation from neighboring parts, so that abscess of the spleen has been secondary to ulcer or cancer of the stomach, to purulent peritonitis and perinephritic abscess, to abscess of the lung, or left-sided empyema by direct extension through the diaphragm.

It has been supposed by some authorities that simple abscess of the spleen may accompany malarial infection by the direct action of the plasmodium malariæ upon the spleen parenchyma. Tasma has repeatedly seen splenic abscess accompany malarial cachexia.

Abscesses in the spleen are occasionally encountered in which the cause cannot be determined either during life or after most thorough post-mortem examination, so that it may be said that the disease may occur under conditions at present unknown to us.

Pathological Anatomy.—In cases of embolic origin the size of the abscess is proportionate to the size of the previous infarction, usually between that of a walnut and a hen's egg. Embolic abscesses are usually multiple. By the coalescence of multiple abscesses or by the extension of infection to the surrounding areas of spleen pulp larger abscesses may be formed. The very large abscesses occasionally reported in literature—as, for example, the case of L'Hermite, in which 15 litres of pus were evacuated by a single incision—are probably not of purely splenic origin, as when so large a pus sac is formed it is impossible to say how much of it is composed of spleen and how much of surrounding tissues. Primary abscesses are usually single, and are, as a rule, much larger than those of an embolic nature, probably because the primary diseases to which the latter owe their origin are so rapidly fatal. The larger abscesses are usually situated in the upper portion of the organ or approaching the outer surface near the anterior border. In abscesses of any size more or less of the adjacent portions of spleen pulp becomes sequestrated, and may be detected in the pus obtained after operation or spontaneous rupture, confirming the diagnosis beyond the shadow of a doubt.

In many cases suppurative foci are found in other parts of the body, so that the abscess of the spleen is only one evidence of a general pyæmic condition.

Secondary abscesses are not uncommon, either in the liver, on the perisplenic tissues, or under the muscles of the anterior abdominal wall just above Poupart's ligament.

The peritoneal coat over the abscess frequently shows vascular injec-

tion or is covered by a fibrinous or a purulent exudate, and may be adherent to the opposing peritoneal surfaces.

In rare instances abscess of the spleen may terminate in gangrene of the organ.

The subsequent course of splenic abscesses varies:

1. In some cases of multiple embolic abscesses complicating septic diseases small purulent foci are found, each with a central necrotic mass surrounded by a zone of hyperæmic and infiltrated spleen pulp, or the parenchyma may run together as a discolored mass of pus, blood, and decomposed spleen elements. The patient is apt to die from the primary disease before the lesions in the spleen have further time to progress.

2. Small abscesses may ultimately undergo encapsulation; the pus becomes inspissated, and may be infiltrated by lime salts.

3. The abscess may perforate in any direction. Perforation into the general peritoneal cavity with peritoneal septicæmia or purulent peritonitis is infrequent, except with abscesses accompanying relapsing fever, because of the formation of previous adhesions obliterating the peritoneal cavity over the site of the abscess. Perforation through the diaphragm into the lung or into the stomach or intestine frequently occurs, and recovery may result from the spontaneous drainage so afforded. Less commonly rupture takes place into the left pleural cavity or into the left kidney. Perforation into the retroperitoneal tissues allows of the formation of a large abscess cavity, the walls of which are only partially composed of spleen tissue and capsule. Spontaneous drainage and recovery may follow rupture through the anterior abdominal wall.

Symptoms.—The symptomatology of splenic abscess is neither characteristic nor constant. In embolic cases complicating such intensely septic diseases as pyæmia or malignant endocarditis the symptoms due to the involvement of the spleen are obscured by those of the primary disease, and the splenic condition usually remains unsuspected.

Should, however, the symptoms of the primary disease be less intense, those due to the splenic abscess become relatively more evident.

The most suspicious symptoms are pain and tenderness over the spleen. These symptoms most commonly indicate a perisplenitis, and are usually absent in deep-seated abscesses, but such an inflammatory involvement of the peritoneal coat is no longer considered essential to their development, as Mosler has proved that splenic pain may be caused as well by stretching of the peritoneal coat, whether by abscess, tumor, or any other cause. The pain may be sharp and localized over the spleen or it may radiate down the left leg or to the left shoulder. In rarer instances the pain may be altogether referred to the latter situation or be felt in the neck: in these cases there is usually detected tenderness along the course of the pneumogastric nerve in the neck. In other instances the pain is dull, throbbing in character, and less sharply localized; the pain increases in severity with the extension of the abscess and the increasing involvement of the peritoneal coat, becomes stationary whenever the lesion ceases to advance, and diminishes or disappears entirely whenever the pus is discharged by operation or by spontaneous drainage.

Fever, which is rarely absent, runs an irregularly remittent course and cannot be distinguished from that of other septic conditions. Toward the later stages of the disease there may be added other symptoms of internal suppuration—erratic chills, cold drenching sweats, rapid emaciation, slight jaundice, and delirium at night.

The spleen is usually enlarged, so that its anterior border may be detected by palpation beyond the costal arch. The enlargement may, however, present no distinctive signs by which it may be distinguished from the acute enlargement that would naturally accompany the primary disease. Fluctuation is a sign of great value, and may be elicited in large single abscesses projecting beyond the free border of the ribs. Lauenstein attributes the greatest diagnostic significance to a high fixation of the diaphragm on the left side, and to the presence of pleuritic râles at the left base and complemental space. Moritz Litten's "diaphragm phenomenon" may be the means of determining the high fixation of the diaphragm in these cases. This phenomenon consists of a wavy undulation which starts from about the sixth rib and passes down the thorax in a horizontal line for two or two and a half inches in normal cases, and which is the visible expression of the gradual detachment of the diaphragm from the walls of the thorax in its inspiratory descent. The sign is of great value in estimating the extent of the respiratory movement of the diaphragm, especially if the phenomenon be absent on one side alone, but it affords no further clue to the diagnosis of the primary condition by reason of which the diaphragm is rendered immobile. Involvement of the peritoneal coat at the site of the abscess is accompanied by peritoneal râles and soft rubbing sounds during the time of the inspiratory depression of the spleen.

An important group of symptoms arises from perforation of the abscess into neighboring organs. Rupture into the left pleural cavity or peritoneum is rare, owing to the presence of previously formed adhesions. Perforation into the bronchi of the left lung is more frequently observed. The pus which is then coughed up, usually in large quantities, may be yellowish, reddish, or even of a chocolate color and of an intensely fetid odor. Septic pneumonia may result. Perforation into the stomach or bowel is followed by the appearance of pus in the vomited matters or in the stools, and a corresponding reduction in the size of the enlarged spleen. In a number of instances rupture occurs both into the lung and bowel, as in a case reported by Mena, in which recovery followed the spontaneous drainage thus afforded by the double outlet. In a case reported by Howe, evidently of multiple splenic abscesses, perforation into the lung and bowel occurred eleven days after one abscess had been opened and drained by appropriate surgical methods. Ruptures through the abdominal wall and into the left kidney are comparatively infrequent.

According to Petrowsky, abscess of the spleen complicating relapsing fever follows one of two types. In one set of cases its chief symptoms are—hectic chills, sweating, loss of strength, and emaciation, with enlargement of the spleen. In other instances left-sided pleurisy, local peritonitis, and a continuous fever are observed, and in these cases the duration of the disease may be protracted to as long as nine weeks.

Diagnosis cannot be made with certainty in the majority of cases.

The condition, should, however, be suspected if the spleen becomes enlarged and tender during the course of pyæmia or malignant endocarditis, or if a remittent temperature complicates the convalescence of typhoid fever without other evident cause, and if, at the same time, the plasmodium malariæ be absent in the blood.

Constant and increasing pain and tenderness over the spleen, progressive enlargement of that organ, failure in general health, and a continued irregular fever are the most marked diagnostic symptoms. The diagnosis can be made with certainty if pus is expectorated or passed by the bowel, with a coincident decrease in the size of a previously enlarged spleen. The detection of fragments of spleen pulp in the pus afford, of course, conclusive proof of its splenic origin.

Duration.—The course of the disease is usually brief, not only because of the serious nature of the splenic condition, but on account of the usually fatal type of the primary disease. The average duration is between one and three weeks. Cases running a longer course are, however, not infrequent, and to these the name of "chronic pyæmic abscess" has been applied. Kriege reports a case of somewhat unusual duration. The patient had suffered for six months from pain referred to the spleen, and for four months had noticed a tender lump under the ribs on the left side which increased slowly. There was such marked cachexia as to suggest cancer of the stomach. The tumor extended from the sixth rib to 10 cm. below the free border of the ribs in the mammary line, reaching the median line. Aspiratory puncture revealed brownish red pus, small fragments of spleen pulp, and many Charcot-Leyden crystals.

Prognosis.—The prognosis is seldom required in actual practice, as the condition is so rarely detected before the death of the patient. The disease, if neglected, is almost certainly fatal, not from spleen destruction, but from sepsis, perforation, or peritonitis. Embolic abscesses are usually fatal by reason of the serious character of the primary disease.

In rare instances perforation and spontaneous drainage may eventuate in recovery, and, as a rarity, inspissation and calcification may result in spontaneous cure.

The prognosis of cases operated upon with improved surgical technique and without unnecessary loss of time is always grave, but never hopeless, as an increasing percentage of recoveries forces the conviction that abscess of the spleen is a condition for which much can be done.

HEMORRHAGIC INFARCTION (EMBOLISM OF THE SPLEEN).

Etiology.—By reason of the large size of the splenic artery and the slowness of the blood current through its branches the spleen is an organ especially susceptible to the lodgement of emboli within it.

In 84 cases of embolism complicating endocarditis Sperling found that the spleen was affected in 46.5 per cent.—a proportion only surpassed by that of the kidney (68 per cent.).

The most important cause for the embolus is malignant endocarditis, in the course of which disease small fragments of the endocardium or of the vegetations which form on it become detached and enter the general circulation. In other cases the emboli arise from detached portions of thrombi in the course of simple endocarditis, atheroma, or aneurysm of the aorta or from primary thrombi in the pulmonary circulation. Hemorrhagic infarction of the spleen is not uncommon in relapsing fever, but is thrombotic in origin in these cases, and originates probably in the venous radicles.

Pathological Anatomy.—When it is remembered that the branches of the splenic artery do not anastomose with each other, being so-called "terminal arteries," it will be seen that each area of spleen tissue supplied by an arterial branch is entirely dependent upon it for its nutrition, and is almost certain to become structurally disorganized whenever its nutrient artery becomes occluded.

When an embolus lodges in a splenic artery, therefore, the condition of coagulation necrosis is induced in the wedge-shaped area to which the artery distributes blood. The wall of the artery as far back as the nearest communicating branch also becomes disintegrated.

The infarction may be "hemorrhagic" or white, but owing to the valveless condition of the splenic veins, which readily allows reflux of venous blood, the former condition is much more common. Areas originally red, however, may become decolorized in time by change in the blood pigment. In other cases the centre of the infarction may be light, while the periphery is red. The general shape of the infarction is that of a wedge, with the base toward the cortex, the apex toward the hilus, being represented by the point at which the nutrient artery is occluded. There is frequently an exudate of fibrin on the peritoneal coating over the cortical base of the infarct.

In the earliest stages may be seen under the microscope a compact mass of red blood cells, among which appears the compressed and necrotic parenchyma. In the white infarctions the general spleen structure may be shown for a short time in the condition of coagulation necrosis.

Infarction of the spleen may be single or multiple. The size varies from that of a large shot to that of half the spleen, or even larger than this.

The subsequent course of the infarction varies according to whether the original embolus is simple or septic in character.

If the embolus is non-infective, the following changes may be observed:

1. The area may become disintegrated, softened, and if small may be more or less completely absorbed. In the early stages, about the periphery of the infarction appears a zone of hyperæmia and cellular infiltration, which in course of time assumes the character of cicatricial tissue, thus forming an investing capsule. The capsule may be white or pigmented. If absorption is incomplete, a cyst may remain with yellowish or brownish fluid contents. If absorption be complete, nothing remains of the infarction but a dense mass of fibrous tissue, which frequently by its contraction draws in the surface so as to cause more or less puckering and deformity of the organ.

2. In other cases the disintegrated area undergoes cheesy degeneration—becomes inspissated and infiltrated by the salts of lime. In the

yellowish gray mass so formed the Malpighian bodies usually stand out prominently as pearly points.

If the embolus be infective, in addition to the mechanical effects already described, the infarction serves as the means of infecting the spleen tissue and of causing metastatic abscess (see Abscess of the Spleen, p. 613).

Symptoms.—The symptoms of embolism of the spleen are neither characteristic nor constant.

In the great majority of cases the condition complicates malignant endocarditis, which by the gravity of its symptoms obscures those caused by the splenic infarction, so that the condition remains unsuspected during life.

More easily to be diagnosed are those cases in which the primary disease runs a quieter course.

Should a patient with endocarditis, or any other disorder which is capable of producing embolism, complain of a chill and pain referred to the situation of the spleen, spleen infarct should be at once suspected. The pain may radiate to the left arm or leg; it may be increased by coughing, straining, or by certain positions of the body. As pain, however, depends upon the presence of local perisplenitis, this important symptom may be absent if the cortex of the organ is not involved. Corroborative diagnosis is afforded by a rapid but moderate increase in the size of the spleen, although the organ may remain normal in size. Thus Sharkey has described a case of malignant endocarditis with multiple infarctions of the spleen, in which the organ after death weighed only four and a half ounces.

Perisplenitis gives evidence of its presence by local tenderness and by peritoneal friction râles. These physical signs occurring in a patient with endocarditis are highly suggestive of splenic embolism.

Febrile symptoms belong only exceptionally to simple embolism, and are seldom pronounced. If the embolus, however, be septic in character, fever is regularly present, and is due either to the original disease, as malignant endocarditis or pyæmia, or to the suppuration within the spleen: in the latter case the fever assumes the hectic character and is accompanied by the characteristic rigors and the symptoms that attend any internal suppuration.

Prognosis depends upon the character of the embolus and the size and number of the infarctions.

The prognosis of septic infarctions is that of abscess of the spleen.

Generally the prognosis of non-infective infarctions is good; even if the greater portion of the spleen is involved, life is not usually threatened.

Treatment.—There are no means at our disposal to prevent embolism of the spleen, so that prophylactic treatment is of no avail. When embolism occurs, the patient should be confined to bed and the bowels freely moved. An ice bag should be applied over the splenic region to diminish congestion and to lessen if possible the chances of suppuration. The temperature should be taken regularly, and the patient carefully watched for the appearance of septic symptoms, as the early diagnosis of abscess of the spleen is of great importance.

Otherwise the treatment is purely symptomatic.

TUBERCULOSIS OF THE SPLEEN.

Primary tuberculosis of the spleen is of such exceedingly rare occurrence that but one case is reported (Scharold). In this case the spleen was found enlarged to three times its normal size and studded with tubercles. Except for slight swelling of the intestinal solitary glands and Peyer's patches no other evidence of disease could be determined. The duration of the disease in this instance was eighteen days.

Secondary tuberculosis of the spleen is a condition quite commonly encountered, usually in connection with acute miliary tuberculosis. The spleen is enlarged and congested, and through its substance are tubercles. The Malpighian bodies are but rarely affected. The tubercles are usually miliary in size, grayish, and translucent. In children, especially those with tabes mesenterica, the tubercles may coalesce to form deposits the size of a pea or hazelnut which may present numerous points of caseation.

Upon section the tubercles may resemble the Malpighian bodies, but, unlike the latter structures, they stand out prominently from the cut section and are rendered more evident when subjected to a stream of water.

Tubercles situated in the capsule may give rise to a localized perisplenitis, so that the peritoneal coating in the neighborhood of the tubercular deposit becomes congested and covered with fibrin.

Symptoms of tuberculosis of the spleen are not sufficient for the purposes of diagnosis. It is impossible to differentiate, with certainty, the enlarged, congested spleen that accompanies miliary tuberculosis or any similar infectious disease from an enlarged, congested spleen in which are disseminated tubercles.

TUMORS OF THE SPLEEN.

The following varieties of neoplasms are found to invade the spleen: fibroma, fibro-sarcoma, lympho-sarcoma, and carcinoma, while myoma and lipoma are occasionally found in the parasplenic tissues. One case of pulsating angioma has been described (Langhaus). Of these neoplasms, carcinoma and sarcoma alone are of clinical interest.

I. Sarcoma.—Primary sarcoma of the spleen is a condition of great rarity.

Weichselbaum reported two cases accidentally discovered at autopsy—one a fibro-sarcoma the size of a walnut, the other of multiple sarcoma, in part fibrous, in part showing the characteristics of endothelioma. To this form he gave the name of "endothel-sarcoma." Both occurred in males twenty-one years of age. Schönstädt reports a case in which the characteristics of fibro-sarcoma and endothelioma were commingled in the same manner: the spleen was infiltrated with the nodules; the twelfth dorsal vertebra and the spinal cord at that level were also infiltrated. The rarity of the condition is also attested by the fact that only five cases of sarcoma of the spleen have been operated upon—one by

Billroth with recurrence and death in six months; one by Fritch with recovery; one by Kocher, with recurrence in the lymphatic glands; one by Frothman, with death in fifty hours from hemorrhage; and one by Wagner, with recovery.

Symptoms.—In the reported cases certain positive symptoms have been present, upon which the diagnosis has been made.

These are—rapid enlargement of the spleen, uneven surface of the growth, great pain.

In Schönstädt's case the tumor appeared in the left hypochondrium, and was distinctly appreciable by rectal examination, its lower border lying at the left sacro-iliac synchondrosis. There was marked tenderness under the sternum and over the entire growth. Left-sided pleurisy with effusion was present, and at the autopsy the spleen was found to be adherent to the stomach and diaphragm. The organ measured 23 cm. by 12 cm. by 7 cm., and weighed 1350 grains. The case terminated fatally after an illness of but four weeks.

In Wagner's case a floating spleen was involved by the neoplasm. Cachexia was noted as an early symptom in all the cases.

Negative symptoms are of value in determining the nature of the disorder. There is no change in the constitution of the blood, and the plasmodia malariæ are not present. The tumor does not give rise to fluctuation nor to hydatid fremitus. Septic symptoms do not appear.

II. **Carcinoma.**—Primary carcinoma of the spleen is so rare that its existence has been doubted by many pathologists. Ten cases of supposed primary origin appear in the literature of the subject, but, according to Ewald, in not a single instance can it be positively affirmed that the growth was really primary in its origin, as in each case the pathological examination was scanty and inconclusive.

Secondary carcinoma is usually secondary to malignant disease of the liver, stomach, or retroperitoneal glands, more rarely of the kidneys. Bramwell reports a case of secondary nodules in the spleen and other organs following a primary growth in the breast, in which it was surmised that the metastasis occurred through the medium of the lymphatics and thoracic duct, thus entering the blood current to become generally distributed.

In the great majority of cases the growths assume the characters of medullary carcinoma, while, according to Eiselt, in 26 per cent. of cases the neoplasm is deeply pigmented. The growths are usually multiple, varying in size from that of a pea to a hazelnut or even larger than this.

Symptoms are, in the main, those which occur with sarcoma. The diagnosis is possible only when rapid enlargement of the spleen, inequalities of its surface, pain, and tenderness coexist with evidences of primary growth elsewhere. The diagnosis from sarcoma cannot be positively made in the majority of instances.

Prognosis is unfavorable. Pigmented carcinomata may run a rapidly fatal course.

Treatment is usually unavailing, as the splenic growth is regularly secondary to malignant disease elsewhere. The rare cases of recovery after splenectomy for primary sarcoma have been already alluded to.

SYPHILIS OF THE SPLEEN.

Pathological Anatomy.—During the earlier stages of acquired syphilis changes in the spleen of a congestive character are not uncommon. According to Weil, the spleen may become enlarged even in the interval between the primary sore and the first cutaneous eruption. The pathological changes consist of acute hyperæmia, with or without the additional characteristics of acute hyperplastic splenitis. The analogy between the secondary lesions of the lymphatic glands and those of the spleen during this period seems to be well sustained. During the period of secondary fever the splenic changes are usually well marked and the spleen may be very considerably enlarged.

Under appropriate treatment, directed toward the causal disease, the spleen usually becomes rapidly reduced to its normal size and appearance. Long-standing congestion or hyperplastic inflammation may, however, lead to more or less permanent enlargement, the spleen showing the characteristic lesions of chronic indurative inflammation.

In old-standing cases of syphilis, especially if accompanied by chronic suppurations or extensive bone disease, the spleen may show the lesions of amyloid degeneration.

The characteristic syphilitic lesions of the spleen may occur toward the end of the secondary period or during the later stages of the disease. They may occur also with hereditary syphilis.

The syphilitic lesions embrace (1) gummata, (2) interstitial splenitis.

(1) *Gummata.*—The spleen is usually enlarged. Throughout its substance are found gummata of varying sizes, usually isolated and well defined, although without an investing capsule. The size of the gummata varies usually from that of a pinhead to a marble, and rarely are they larger than an inch or an inch and a half in diameter. Although scattered throughout the organ, they are usually more numerous near the surface. Recent gummata are grayish red, and of an apparently homogeneous structure; they are tougher in consistence than the spleen parenchyma and contain considerable blood.

Old gummata are gray or grayish yellow in color, are dry, tough, and in places almost cheesy.

The minute anatomy is that of gumma in general, so that a detailed description of the new growth is not deemed to be necessary.

There is usually a complicating perisplenitis resulting in irregular connective-tissue thickening of the capsule, and adhesions are apt to be formed connecting the spleen with other adjacent structures. In the great majority of cases splenic syphilis occurs as a complication of similar changes in the liver.

(2) *Interstitial Splenitis.*—In this form the spleen is at first enlarged and soft; the pulp is rich in cellular elements. In the later stages the process goes on to connective-tissue formation, often to a marked degree. The spleen then becomes permanently enlarged and hard to the feel. resembling on manipulation the extreme toughness of amyloid degeneration of the organ. Complicating perisplenitis, with thickening and irregularities of the capsule, usually occurs, and adhesions are apt to be formed. If the connective tissue appears in the forms of dense bands penetrating the organ, cicatricial contraction may result in puckerings

of the surface of the organ, which may deform the appearance of the spleen to a very considerable extent.

In *inherited syphilis* enlargement of the spleen is not infrequent, occurring in from one quarter to one third of the cases. The splenic lesion consists either in gumma or in chronic indurative inflammation. In either case there is usually a perisplenitis with thickening and irregularities of the capsule, and the spleen is apt to be adherent to the surrounding structures.

In children with congenital syphilis the enlargement of the spleen may continue for two or three years after the subsidence of all other syphilitic manifestations, and, according to Eisenschnitz, enlargement of the spleen in children without other discoverable cause is highly suggestive of this condition.

Symptoms.—There are no characteristic symptoms by which syphilitic disease of the spleen can be diagnosed. The enlargement of the organ during the earlier stages of the disease is no more diagnostic of syphilis than is the same condition diagnostic of any other infectious disease. Gummata of the spleen are to be suspected if during the later stages of syphilis rapid enlargement of the organ occurs, with surface irregularities and the characteristic symptoms of perisplenitis. Corroborative aid to diagnosis is afforded by the frequent presence of gummatous involvement of the liver.

The brilliant results observed by timely treatment are, however, the crucial test for diagnosis.

Prognosis of all forms is generally good if the treatment be begun before connective-tissue or degenerative changes have had time to develop.

Treatment consists in the energetic application of antisyphilitic remedies upon the well-known general principles.

CYSTS OF THE SPLEEN.

The following varieties of cysts within the splenic tissues are to be described:

I. Serous and blood cysts;
II. Dermoid cysts;
III. Hydatid cysts.

I. (*a*) Serous and (*b*) Blood Cysts.

(*a*) *Serous cysts* not of parasitic nature are exceedingly rare. Andral reports a case of a small serous cyst in the centre of the spleen. Lendet describes a case of multilocular serous cysts lined with endothelium in the interior of a spleen which was not enlarged.

Böttcher reported an interesting case of multiple serous cysts in an amyloid spleen. The cysts varied in size from that of a flaxseed to a pea, and upon the walls could be seen evidences of a reticulated structure. Certain of the cysts were traversed by fine connective-tissue

trabeculæ. The inner lining membrane was composed of a single layer of flat endothelial cells. Böttcher ascribed the formation of the cysts to occlusion of the arterioles, from the amyloid degeneration of their walls, with fatty degeneration, softening, and sloughing, in parts, of the spleen pulp.

Except in Böttcher's case the pathogenesis of simple serous cysts of the spleen appears to be the same as that of similar cysts elsewhere.

(*b*) *Blood cysts* are much more frequently encountered than those of serous character, and originate from a previous hæmatoma. Besnier believes that in many instances the source of the original hemorrhage is between the capsule proper and the peritoneal covering of the organ. Cases of cyst following subcapsular hæmatoma are certainly more common than the cases following central hemorrhage. It is possible that certain reported cases of central blood cyst have really been examples originally of the simple serous variety, into which secondary hemorrhage has occurred. The size of the cyst varies. In Péan's case the cyst contained three litres of a fluid which showed the characteristics which blood assumes when it is retained for any length of time in the body. By the occurrence of successive hemorrhages into the cyst cavity the size becomes progressively increased. The color of the cyst fluid varies from yellow to yellowish red, red, brown, or even black.

The consistency of the cyst contents varies according to the richness of the fluid in serum or the extent to which absorptive processes have progressed. Cholesterin crystals are almost constantly present in cases of old standing.

In a case reported by Spencer Wells, in which the clinical symptoms consisted of chills, fever, sleeplessness, anorexia, and signs of localized peritonitis, the cyst fluid contained large numbers of white cells. The fluid usually responds to the test for albumin. A detailed account of a blood cyst of the spleen is given by Bardenheuer. The cyst, which was of the size of a child's head, was situated in the lower portion of the organ, and was surrounded by a zone of compressed and atrophied spleen structure forming a capsule in which deposits of lime salts were to be seen in streaks. The inner surface of the cyst wall showed a reticulated structure traversed by large bloodvessels, but there was no limiting endothelial layer as in the case of simple serous cysts. The fluid contents were of a dark chocolate color containing blood pigment and cholesterin crystals.

In the majority of cases the origin of the cyst can be traced to some violence or contusion of the splenic region. Credé has called especial attention to the occurrence of splenic cyst after contusion, and has reported a case in which 1350 gm. of clear yellowish fluid, containing cholesterin crystals and a trace of albumin, were removed by operation. In Credé's case there was an internal limiting membrane of endothelial cells. Jakoulieva reports a case of cyst following the throes of labor in which the cyst was subperitoneal, and was separated from the splenic parenchyma by a wall of connective tissue 2-5 mm. thick. The source of the original hemorrhage was probably a subcapsular hemorrhage (*rupture sèche* of Collins).

In another case, reported by Sabbotic, the cyst was also subperitoneal,

and followed the rapid enlargement of the spleen during a severe attack of malarial fever: 1500 cm. of dark blood-colored fluid containing coagula were removed by operation, but no signs of rupture of the spleen were discovered. Sabbotic refers the origin of this case also to hemorrhage from the capsule.

Sir Spencer Wells's case developed after the reposition of an enlarged dislocated spleen.

SYMPTOMS.—*Serous cysts* of the spleen usually arrive at some little size before they cause definite symptoms. As soon as the cyst has sufficiently developed, symptoms due to mechanical weight and pressure appear—feelings of heaviness in the left hypochondrium, pain on motion or on lying in certain positions, together with symptoms of the functional derangement of the neighboring organs that may be compressed.

Blood cysts usually develop more quickly, although a considerable time may elapse between the first symptoms noted and the full development of the cyst. Credé's case is interesting in this regard. Ten years before the operation the patient injured the left side and suffered from pain over the spleen for five days. The pain gradually subsided, leaving occasional sharp sticking pains in the same locality, which continued until the time of operation. The year before the operation he noticed a tumor under the left arch of the ribs, which increased so much in six months that he could not work. Some pain was complained of, but tenderness was elicited only by very rough manipulation. The tumor was of the size of a child's head, fluctuating and freely movable. The character of the fluid contents already alluded to shows the cyst to have been of considerable duration.

In Jakoulieva's case the cyst arrived at its maximum development in seven weeks.

In blood cysts rapid increase in size may be observed from time to time from recurring hemorrhages taking place into their interior. Great pain attends these rapid enlargements, and is evidently due to the stretching of the peritoneal coat.

As the weight of the cyst increases the spleen may become loosened from its attachments and become dislocated. Such a floating spleen may be even found in the pelvic cavity, and in its new position it may be adherent or may remain freely movable.

In Jakoulieva's patient the tumor appeared in the pelvis. Péan and Bardenheuer both diagnosed their cases as ovarian cysts. In Péan's case the cyst was so large that the uterus was immobilized and the anterior vaginal wall was bulged. The spleen gives evidences of considerable enlargement, and its surface may be smooth or lobulated. Usually the contour, as determined by palpation, is unsymmetrical.

The most characteristic physical sign is fluctuation. This sign is usually, but not invariably, present, so that its absence does not exclude the cystic character of the tumor.

In rare cases rupture of the cyst has occurred. Suppuration of the cyst is even more rare.

The DIAGNOSIS of cystic spleen is to be made from the following conditions:

1. Cystic disease of the left kidney. Here the position of the tumor

and the results of urinary examination afford sufficient means for diagnosis.

2. Hydatids of the left lobe of the liver. The diagnosis is to be made by the results of percussion, there being in this condition a zone of tympany between the liver and the spleen.

3. Ovarian cysts. The diagnosis of cystic spleen from ovarian cyst is one of great difficulty. In many cases an exploratory laparotomy is indicated as the only means of arriving at a positive diagnosis.

4. Effusion in the left pleural cavity may be mistaken for cysts of the upper portion of the spleen, but in effusion the percussion outline is of different shape and respiratory symptoms are present.

5. The differential diagnosis from hydatid cyst is to be made only by incision or aspiration, as fremitus in the latter condition is a most inconstant sign. Generally the diagnosis of hydatid cysts is to be given the benefit of the doubt, as the non-parasitic cysts are extremely rare.

Prognosis of small cysts is generally good. The outlook for those of larger size is favorable if the treatment be on approved surgical principles and if the technique be faultless. Retrograde changes in the cyst may occur, with thickening and calcification of the capsule, and with partial absorption of the contents, so that a spontaneous cure may result.

Such a termination is, however, comparatively rare.

Blood cysts show a greater tendency to grow because of the possibility of repeated hemorrhages taking place into their interior.

Treatment is but seldom resorted to, owing to the rarity of the affection and the difficulty of establishing the diagnosis.

The old method of treatment consisted in aspirating the cyst and injecting some irritant, as tincture of iodine, in the hope that the adhesive inflammation so induced would obliterate the cyst cavity. This form of treatment, however, is neither curative nor devoid of risk.

The modern method of treatment consists of incision or complete or partial splenectomy.

Ledderhose recommends incision when the following conditions are present: 1. When the cyst is very large; 2. When the spleen is closely adherent to the abdominal wall and neighboring viscera; 3. When there is inflammation of the cyst.

According to the same authority, splenectomy is indicated—1. When the cyst is not too large; 2. When the spleen is readily removable; 3. When the cyst wall is extremely thin, so that there is danger of rupture; 4. When the cyst is so situated that a considerable thickness of spleen pulp must be incised in order to reach the cyst.

II. Dermoid Cysts.

Dermoid cysts occurring in the spleen are practically unknown. One case alone has been reported in literature (Andral).

III. Hydatid Cysts.

Synonym.—Echinococcus.

Etiology.—The general etiology of echinococcus has been elsewhere

given in detail (see p. 538). The disease occurs usually in young adults and affects both sexes equally.

Rare as the affection is in the human body, in the United States, at least, hydatid cysts are even more rarely developed in the spleen. Hydatid cysts in this organ most commonly coexist with similar developments in other abdominal viscera, especially in the liver. Relatively much less frequent are the cases in which the spleen alone is involved, the so-called "solitary hydatid" of the spleen. In 235 cases of abdominal hydatids Finsen found but 2 instances in which the spleen alone was involved. Other observers give a somewhat greater percentage than this. Frey's statistics give 3.5 per cent.; Neisser finds 2.87 per cent.

Pathological Anatomy.—The seat of the hydatid cyst is usually in the gastro-splenic omentum or under the serous capsule; more rarely does the cyst develop within the gland parenchyma. The size varies up to that of a cocoanut, rarely exceeding this in its dimensions. As the cyst increases in size it induces a pressure atrophy upon the gland, most marked in the cases of central growth, so that in time the spleen may become converted either to a firm hard shell encapsulating the parasitic growth or to a shrunken mass lying upon the periphery of the sac. In an extreme case reported by Saeller in place of the spleen was found a round tense body, upon the lower posterior surface of which could be seen the spleen much atrophied and shrunken. The tense elastic growth consisted of a hydatid cyst, originally situated at the hilus, weighing over three pounds and containing seventy-four larger and smaller daughter cysts of from a half to one inch in diameter.

The fluid contained within the cyst presents certain individual peculiarities. Resembling clear water in its appearance, it is of neutral reaction, contains no albumin, but is rich in sodium chloride. Upon the addition of a solution of ferric chloride the fluid assumes a brown color, thus indicating the presence of succinic acid. More characteristic is the presence of hooklets, scolices, and bits of laminated cyst membrane, but these elements are not always obtained by aspiratory puncture. If suppuration or inflammation of the cyst wall occur, hooklets and scolices are but rarely present; the fluid may be turbid and contain albumin.

The following events may occur in the growth of hydatid of the spleen:

I. *Death of the Echinococcus.*—When this occurs the development of the cyst is terminated, the fluid contents are partially absorbed, and the capsule in time becomes calcified. Spontaneous cure then results. This fortunate termination occurs, however, in but a small percentage of cases.

II. *Rupture and evacuation of the cyst* are much more frequent, the cyst showing a disposition to rupture into the thoracic abdominal cavity according to whether the upper or the lower portion of the spleen is invaded by the parasitic growth. Perforation into the general peritoneal cavity is rare, this accident being usually prevented by the formation of adhesions reinforcing the weak point of possible rupture. Perisplenitis complicating hydatid cyst of the spleen is therefore another instance of the conservatism of Nature.

When rupture into the general peritoneal cavity occurs, the direct

cause can usually be traced to traumatism. When adhesions form perforations may occur into the bronchi, left pleural cavity, stomach, colon, or the left kidney. Duroziez reports a case in which the patient coughed up a substance resembling the boiled white of an egg, but which proved to be the débris of a hydatid cyst. The autopsy showed the spleen to be hollowed out into a vast cavity containing thick, dark-colored liquid with brownish flocculi and communicating with the left bronchus. Berthelot describes a case in which rupture occurred in the colon; after twelve hundred vesicles had been discharged by rectum the patient made an uncomplicated recovery. Hope-Grant gives the history of a case of hydatid of the spleen in which the patient voided with the urine two chamberfuls of hydatid liquid, with a complete subsidence of the tumor. Ten years later there was passed by rectum, with forcing pains, a mass consisting of characteristic cyst membrane. The tumor did not again develop to its former size, but there remained tender spots over the spleen and the patient continued to pass pus by the bowel.

Symptoms.—During the early stages of hydatid cysts there are usually no symptoms referable to the spleen, although Mosler has observed pain as an early symptom, starting in the left hypochondrium and extending to the left lumbar region. In course of time, however, the patient experiences a sense of dragging and weight referred to the left hypochondrium, and pressure symptoms are apt to occur. The latter group are exceedingly various. Loss of appetite, nausea, vomiting, and constipation are commonly present, and there may be moderate dyspnœa. Compression of the left ureter may occur. Martineau describes a case in which pressure on the lumbar plexus occasioned pain in the left thigh and leg, diminished tactile sensibility, and flexure of the left thigh. There may be pain of a sharp, sticking character in the side from perisplenitis or a pleurisy at the left base. When the cyst becomes large the continuous dragging on the peritoneal attachments may allow of their lengthening, so that the spleen becomes displaced and movable, and may give rise to any of the symptoms occasioned by wandering spleen.

Inflammation of the sac is made known by an increasing pain referred to the splenic region. The tumor becomes harder and more tense; the whole spleen becomes enlarged. Irregular chills, erratic rises in temperature, and drenching sweats betoken internal suppuration. There may be œdema and redness of the anterior abdominal wall over the affected region.

Perforation into the peritoneal cavity, while a serious complication, is not one necessarily fatal. Skoda narrates a case of this nature in which sudden abdominal pain, rigors, small wiry pulse, and cyanosis were the principal symptoms. Resorption of the fluid in five days was followed by recovery.

Physical Signs.—In the early stages, before the characteristic tumor can be felt, a positive diagnosis cannot be made. Besnier has determined that at least two years must elapse before the growth becomes appreciable. The characteristic tumor is usually one of about the size of the fist, soft, elastic, and smooth. Fluctuation is usually appreciated, but hydatid fremitus is but rarely observed. The latter sign may, however, be elicited by deep inspiration or by changes in

the patient's position. Fremitus, even when present, is not, however, an absolutely sure indication of hydatid cyst. Potain, for example, detected fremitus in a fluctuating tumor apparently projecting from the splenic region, which proved at autopsy to be a hydronephrotic sac.

According to Frerichs, fremitus is only present when the sac is lax and contains other vesicles. Hydatid cysts are usually insensitive; more rarely there is tenderness on pressure. If perisplenitis be present, peritoneal friction râles may be heard over the affected organ.

Diagnosis is rendered positive only by the withdrawal of the characteristic cyst fluid by exploratory puncture. Its peculiarities have been already described. To obtain the hooklets, Henoch insists upon the importance of not allowing the patient to lie for any length of time upon the back before the fluid is withdrawn for examination, as otherwise the hooklets sink by gravity to the most dependent portions of the hydatid sac.

After the withdrawal of the fluid by aspiration a distressing attack of urticaria is likely to ensue, which, according to Henoch, is due to the leakage of a drop or so from the puncture into the peritoneal cavity, resulting in the irritation of the peritoneum by succinic acid contained in the fluid.

Hydronephrosis may present very similar physical signs to those yielded by a hydatid cyst of the spleen displaced downward, but the fluid obtained is of entirely different character, and in hydronephrosis the cause for the condition is to be found in some slowly increasing obstruction of the ureter.

The diagnosis from an ovarian cyst having an elongated pedicle is at times one of extreme difficulty.

As a practical rule, hydatid cyst of the spleen should be suspected in the case of every tumor of that organ unaccompanied by functional or constitutional disturbance or by leucæmic changes in the blood.

Prognosis of neglected cases is poor, the disease usually terminating fatally from the disturbance occasioned by the compression of neighboring abdominal organs or from perforation. Should inflammation of the sac occur, the prognosis is that of primary abscess of the spleen.

Of operative cases the prognosis generally is good.

Treatment.—The oldest method of treatment is by simple puncture and the removal of the fluid. This procedure is now abandoned except as a means of temporizing until more radical treatment can be employed, because there is no case on record of a permanent cure thus afforded. The fluid rapidly accumulates, although in a case reported by Wassiljew a year elapsed before the cyst returned to its former size. Puncture of the cyst and the injection of an irritant, as tincture of iodine, is a procedure not wholly devoid of risk and is not to be advised.

The modern plan of treatment is either by incision or by exsection of the spleen. Incision is to be performed on general surgical principles, and the cyst membranes are to be thoroughly removed by curetting.

Extirpation of the entire spleen is deemed by some the safer procedure, as there is less danger of secondary hemorrhage. Experience shows that after incision and enucleation of the cyst a secondary sple-

nectomy has frequently been indicated, owing to alarming internal hemorrhage.

Finkler's statistics for echinococcus give 42 per cent. mortality in pre-antiseptic days, and 21 per cent. mortality with modern technique. Hahn reports 7 cases with 5 recoveries; Spanton gives 4 cases with 4 recoveries. In the cases terminating fatally after splenectomy extensive adhesions of the cystic spleen to the stomach, intestines, and diaphragm have made the operation one of great difficulty.

If suppuration of the cyst occur, the indications for treatment are those of splenic abscess.

WANDERING SPLEEN.

Definition.—An important distinction is to be made between the wandering or floating spleen and one that is passively displaced. Under the latter class may be included the following changes in the position of the organ:

The spleen may be displaced downward by left-sided pleural effusions, pneumothorax, vertebral curvatures, or deformities of the thoracic wall. Displacement downward and forward occurs during inspiration, and is of the utmost value in determining the size of the spleen by palpation. The spleen may, on the other hand, be displaced upward and backward by any increase in the abdominal contents, such as gaseous accumulations in the stomach or intestines, overloading of the stomach, fecal impactions in the colon, or abdominal tumors.

Passive dislocation may also occur by the contraction of peritoneal adhesions between the spleen and other parts.

The term "wandering spleen" should be applied only to those cases in which the spleen assumes an abnormal position within the abdominal cavity by reason of its increased weight or laxity of its retaining ligaments, without reference as to whether or not it remains freely movable or becomes fixed by inflammatory adhesions in its new position. In consideration of this latter circumstance the term "movable spleen" is frequently a misnomer.

Etiology.—The spleen leaves its original position and sinks downward in the abdominal cavity whenever the retaining ligaments are unable to hold the organ in its place. In rare instances there appears to be a congenital laxity or abnormal length of the suspensory ligament and the gastro-splenic omentum, and this is not improbable when the manifold congenital anomalies of the mesocolon are brought to the mind. Cases of congenital wandering spleens in different members of the same family have been described. In the great majority of cases, however, the ligaments are sufficient to retain a normal spleen in position, but yield to continual traction whenever the organ becomes sufficiently enlarged and increased in weight. Thus the primary cause for wandering spleen is usually found in leucæmic or malarial enlargements, local inflammations, cysts, or neoplasms of the organs. The downward displacement of an enlarged spleen is, moreover, favored by the stretch-

ing of the abdominal wall by repeated pregnancies, so that wandering spleen is most common in women who have borne children.

In some instances traumatism appears to be the exciting cause for the displacement, so that the complaint seems to date from the lifting of a heavy burden or a blow or fall. In many cases, however, it would seem as if attention was first attracted to the already displaced organ by reason of the traumatism. It has been denied by some authorities that a normal spleen ever wanders to any great extent. It is impossible, however, to be dogmatic on this point, as wandering spleens frequently tend to become smaller in course of time. Thus Martin was enabled to remove a wandering spleen through the vagina. On the other hand, wandering spleens may become congested and undergo hypertrophy, so that it is impossible in the late stages of the disorder to accurately estimate the influence which a primary enlargement of the spleen may have had upon its displacement. It may be safely asserted, however, that, except in congenital cases, acquired abnormalities of position usually, but not invariably, indicate a primary splenic enlargement.

Pathological Anatomy.—The spleen sinks downward to the left inguinal region, and in diagonal or right-sided positions of the body may reach into the pelvis or the right iliac fossa. The organ has even been found in inguinal hernias. In its excursions from the left to the right inguinal regions the spleen describes an arc the radius of which is represented by the elongated pedicle. The long diameter of the spleen is usually coincident with the arc in which it travels : the superior and anterior borders project forward and lie against the abdominal wall, so that in many instances the notches on its border can be distinctly felt. The hilus points upward, and pulsation of the entering bloodvessels can frequently be appreciated by palpation.

In its new position the spleen may become permanently fixed by adhesions or the organ may remain freely movable. Adhesions frequently modify the original position, so that palpation fails to reveal the characteristic physical signs previously described.

As the splenic vessels run parallel to the pancreas, the tail of that organ may be bent downward at a sharp angle with the head of the pancreas, and may even be spirally wrapped around the pedicle.

Movable spleens may revolve about the axis of the pedicle, so that by torsion the patency of the splenic bloodvessels may be destroyed.

As the result of torsion of the pedicle secondary lesions of the splenic pulp may occur. In some instances the spleen atrophies, undergoes fatty degeneration and softening, and becomes pigmented. In a case described by Rokitansky the spleen was found of the size of a goose egg, the capsule was shrunken, and the parenchyma was converted to a yellowish red mass of doughy consistency in which was found an area rich in cholesterin crystals. In rare instances the spleen becomes finally converted into a mass of connective tissue.

In other cases the torsion of the pedicle leads to great congestion and enlargement of the organ, which may eventually terminate in its rupture. In rare instances of wandering spleen symptoms of pressure and traction on other abdominal viscera may occur. Collins reports a case in which death resulted from intestinal obstruction by pressure of the spleen on the sigmoid flexure. Babesius reports a case in which

intestinal obstruction was caused by a loop of the jejunum engaging between the vertebral column and the elongated gastro-splenic omentum. Alonzo describes a case of intestinal obstruction caused by the compression of the transverse colon between the spleen and the displaced tail of the pancreas. Klebs and Helm narrate a case of gangrene and perforation of the fundus of the stomach from the disturbed circulation caused by the traction on the nutrient bloodvessels.

Symptoms.—There are no symptoms characteristic of wandering spleen, and there are even many instances in which the condition has existed for years without causing the slightest discomfort to the patient, the displacement of the organ being accidentally discovered by a routine physical examination of the abdomen.

In the majority of cases the patient complains of pain and a sense of weight and pressure in the left lumbar region. The pain may be steady, paroxysmal, or may be induced only by exertion. It is usually more intense during the period of digestion. The pain may be directly referred to the displaced organ, or it may be referred to the heart, stomach, or back. Tenderness on palpation occurs only if there be perisplenitis.

Important symptoms result from the *pressure of the spleen on other abdominal organs*. Dyspeptic symptoms, especially reflex vomiting, are common. Constipation or dysenteric symptoms may result from pressure on the large intestine. Menstrual disorders may occur, and, if associated with irritability and tenesmus of the bladder by pressure, may suggest a pelvic growth. There may be paresis or disagreeable feelings of tingling or formication in the lower extremities.

Psychical disturbances of various kinds of reflex origin have been described by Albert. The occasional occurrence of intestinal obstruction by compression has been previously alluded to.

Symptoms due to torsion of the pedicle are alarming and rapid in their onset. The patient complains of sudden agonizing pain, the abdomen becomes rapidly tympanitic and tender, and vomiting becomes distressing and persistent. The temperature at first remains near the normal, but later there is a slight irregular rise to 100°–102° F. Physical examination shows a rapid and decided increase in the size of the displaced spleen. Should rupture of the congested organ occur, the patient will pass into collapse and evince symptoms of acute anæmia. Death may then result by the second day, as in a case of Beeson's, in which three points of rupture were found in the rounded portion of the spleen opposite the attachment of the twisted pedicle.

Diagnosis.—The easiest cases are those in which the spleen lies in the iliac fossa, and in which the notches, the concave surface, and the hilus, with the afferent bloodvessels, can be distinctly appreciated by palpation. The diagnosis is rendered more difficult when the spleen becomes fixed by adhesions in such a position that these diagnostic points cannot be felt. Corroborative proof in all cases is afforded by tympany on percussion replacing the regular area of splenic dulness. The use of the induced current to obtain contractions of the organ has been recommended in doubtful cases. Vaginal examination should be resorted to in all low-lying displacements, as valuable aid is afforded by this method of diagnosis.

Wandering spleen has been mistaken for the following conditions: pyosalpinx, pelvic growths, uterine or tubal pregnancy, floating kidney, movable ovarian tumors, carcinomatous nodules of the peritoneum (especially if freely movable), and fecal impactions in the sigmoid flexure.

Prognosis is generally favorable. The condition usually occasions but slight annoyance, and the symptoms may be greatly relieved by appropriate treatment. Death occurs only in exceptional cases. In many cases the prognosis depends upon the primary cause of the enlargement of the spleen to which the displacement is secondary.

Treatment.—The most important part of the treatment consists in the reduction of the size and weight of the organ. Quinine and arsenic should be given in malarial cases, and residence outside of malarial districts insisted upon. Leucæmic and pseudo-leucæmic enlargements should receive their appropriate treatment. The use of the induced current may be found of service. Injections of ergot and of 3 per cent. solutions of salicylic acid into the substance of the organ have been advised, but this method of procedure is not devoid of danger. In all cases depletion of the portal system of circulation by moderate catharsis and the use of cholagogues are of service in reducing congestive enlargements.

In many instances the spleen may be replaced by manipulation, and kept in place by a firm elastic abdominal bandage or an inflated air bag properly applied. The results following this simple procedure are frequently good. Removal of the displaced spleen is to be advised, as first recommended by Kirchenmeister in 1856, in serious cases, and the operation is giving better results as the surgical technique improves. Ledderhose reports 14 cases with 12 recoveries. Stanton's statistics give 9 cases with 9 recoveries. The indications for operation are—continuance of severe symptoms not benefited by replacement and abdominal support, fixation of the spleen by adhesions so that replacement becomes impossible, and torsion of the pedicle. The contraindications are—extensive blood changes and an enormous size of the displaced organ. Removal of a wandering leucæmic spleen should never be attempted, as the results of the operation are almost certainly fatal.

In properly selected cases there appear to be no serious sequelæ. Unnatural drowsiness and a leucocytosis lasting for three to six months have been recorded in a few instances.

RUPTURE OF THE SPLEEN.

Etiology.—The spleen is more frequently ruptured than any of the other abdominal viscera by reason of its peculiar texture, its rapid variations in size, and its exposed position when it is sufficiently enlarged to present itself beyond the costal arch. A tendency to rupture exists whenever the spleen becomes so much increased in size that overstretching of its capsule occurs, especially if, at the same time, the spleen substances become softened. Under these predisposing conditions rupture of its capsule may be caused by external violence, by

blows, kicks, or falls, or even by such slight traumatisms as coughing or vomiting. By some authorities a distinction is made between traumatic and spontaneous rupture. Under the former heading are most properly included those cases in which a normal spleen is torn or lacerated by severe falls, crushing, buffer accidents, or by the penetration of a broken rib, foreign body, or the careless insertion of an aspirating needle. The number of cases, however, in which a healthy spleen has been ruptured by direct traumatism is decidedly small. Under the heading of spontaneous rupture are properly included those cases in which the cause for the accident is trifling or unknown. It is evident, however, that a strict line of demarcation cannot be drawn between these two substances, as trifling injuries so frequently provoke apparently spontaneous lacerations.

Rupture of the spleen, being favored by soft enlargements of the organ, is most common in those countries in which severe malarial fevers are endemic. In Mauritius rupture of the spleen is, according to Pellereau, the most frequent cause for sudden death. During two and a half years spent in India, Playfair made 20 autopsies of this condition, and in all cases the spleen was found large and soft from malarial disease. "A person with enlarged spleen," he says, "holds on to life by a very slight thread, for a blow which would not injure an infant may in him cause death." Among the causes which may induce rupture in malarial subjects he mentions slaps with the open hand, slight falls or pushes, or even contraction of the abdominal muscles. These cases possess great medico-legal interest.

The enlarged spleen of leucæmia, typhoid or typhus fever, relapsing fever, miliary tuberculosis, or of any infectious disease may be ruptured by trifling traumatisms in like manner. Rupture may also result from the breaking down of a hemorrhagic infarct or by the giving way of various enlargements or of aneurysms of the splenic vessels.

Rupture of the spleen during pregnancy or labor has been frequently observed, and is one of the causes of sudden death during the puerperal state. Simpson attributed these cases to physiological leucocytosis occurring during pregnancy, inducing an enlargement and softening of the spleen, which render the organ susceptible to rupture from slight violence. The accident is most liable to occur during the throes of labor or during the convulsions of eclampsia, but Wilson has reported a case in which death from rupture was caused by jumping from a chair a fortnight after delivery. Rupture of the spleen has been observed in new-born children after manual extraction during severe labor. According to Parrot, a predisposing cause for such a rupture is to be found in a congenital enlargement of the spleen of syphilitic origin. Hemorrhage into the spleen and rupture of its capsule may also occur with the severe forms of purpura hæmorrhagica. It is unknown whether bleeders are more liable to rupture than are other people. Burr reports one case: rupture of the spleen occurred in a bleeder without known cause, but in this case the spleen was found at autopsy to be enlarged to twice its normal size and displaced into the left iliac fossa.

In rare instances no existing or predisposing cause for rupture can be determined, and these cases may, for want of exact knowledge, be designated as "idiopathic." Thus Atkinson describes the case of a female

who for four weeks complained of irritable stomach, vomiting, and gastric pain. After an attack of vomiting she developed severe abdominal pain, passed into collapse, and died in twenty hours. The autopsy showed a pale, flabby, softened spleen, with a large rent in the gastro-splenic omentum.

In animals the spleen is not infrequently ruptured by external violence, the accident most commonly occurring in dogs and horses.

Pathological Anatomy.—The rupture may be single or there may be two or more simultaneous rents in the capsule. In the spontaneous cases single ruptures are usually found ; multiple ruptures are usually due to severe violence, but are not, however, absolutely distinctive of traumatism. The rent is usually linear and gaping, except in the cases of laceration of the spleen tissue by the fractured end of a rib, foreign bodies, or stab or gunshot wounds.

The point of rupture may be at any part of the organ, with especial frequency, however, on the outer surface.

Traumatic ruptures of enlarged malarial spleens are usually located in the lower portion of the organ, the large rents being on the outer surface, the small points of rupture occurring near the hilus. If there be multiple points of rupture, they are most apt to converge toward the hilus. The rupture involves not only the capsule, but more or less of parenchyma as well. There may be a complete or partial separation of the capsule from the parenchyma by extravasation of blood, and in certain cases a primary subcapsular hæmatoma may be followed after a lapse of hours or days by rupture of the capsule and the escape of blood into the peritoneal cavity. Collin has described a form in which fissures of the capsule occur in enlarged spleens without actual hemorrhage (the *rupture sèche*) ; these possess a clinical interest only by the possibility of their being precursors of extensive hemorrhage. In cases not directly due to extreme external violence the spleen is usually found enlarged, soft, and anæmic. In extreme degrees of rupture the organ may be broken into a number of segments cemented together by coagulated blood. The peritoneal cavity is filled with fluid and clotted blood, but peritonitis does not occur unless the rupture follows a softened and purulent infarction. In case of previous adhesions the blood may be shut off from the general peritoneal cavity. There may be no post-mortem evidences of external violence even in the cases in which undisputed traumatism was the actual cause for the rupture.

Subcapsular hemorrhages may in time develop into the so-called "blood cysts."

Symptoms.—At the time of rupture the patient experiences intense pain and tenderness, referred to the splenic region, which soon become generally distributed over the entire abdomen. There may be the feeling as if "something had broken within." Symptoms of internal hemorrhage and shock soon develop. Pallor, small rapid pulse, cold skin and extremities, faintness, sighing respirations, with dyspnœa amounting to "air hunger" in extreme cases, and vomiting comprise the symptom-group. Moderate fever almost regularly follows, although there may be noted an initial fall to subnormal for a few hours after the accident. Symptoms of peritonitis are not observed except in case of rupture of an abscess or softened infarction of the spleen. Rare cases are

reported in which rupture of the spleen into the stomach or intestines is followed by vomiting of blood or bloody stools. In a small number of cases pain and tenderness over the spleen precede the symptoms of hemorrhage and shock by a number of days. These are the cases in which a primary subcapsular hæmatoma ruptures ultimately through the capsule—the "rupture médiate" of Besnier. On physical examination the abdomen is found to be enlarged and to present the sign of free fluid in the peritoneal cavity. Kernig was able to follow, by percussion, the gradual increase of exuded blood from the left to the right inguinal fossa within the twenty-four hours immediately following a rupture of the spleen. In those cases in which the spleen has been much enlarged a diminution of its size may be noted.

Diagnosis.—The diagnosis can only be made with certainty when symptoms of intense sudden anæmia are associated with the diminution in size of a previously enlarged spleen and the appearance of a free intraperitoneal exudate. In traumatic cases the history of the case and the presence of ecchymoses afford material aid. In many cases, however, no diagnosis can be made during life. The *ruptures sèche* of Collin possess no characteristic symptoms by which they may be diagnosd.

The diagnosis should be made from the following conditions:

1. *Rupture of Echinococcus or other Cystic Growths of the Spleen.*—Here the previously enlarged spleen becomes at once reduced in size and a free peritoneal exudate appears, but anæmic symptoms are wanting.

2. *Rupture of Abscess of the Spleen.*—The collapse symptoms may closely resemble those of intraperitoneal hemorrhage, but anæmic symptoms do not appear, while symptoms of septic intoxication rapidly develop.

3. *Rupture of other Abdominal Viscera.*—The previous history of the case and the localization of the initial pain are important points of differential diagnosis.

Prognosis.—The great majority of cases terminate fatally within a few hours, although it is possible for a patient to live six days after the accident. There are foudroyant cases in which death results within a few minutes. In the cases reported by Playfair the shortest duration was two and three minutes, the longest was twenty minutes, the average duration was between seven and eight minutes. Rupture due to the breaking down of a septic infarction may induce a fatal peritoneal septicæmia, or, should the patient survive a sufficient length of time, a diffuse purulent peritonitis. It is possible for spontaneous recovery to follow simple ruptures of the spleen. Thus cases of recovery have been reported by Kernig, Miller, and Moxon. According to Vincent, the prognosis is not always bad if immediate laparotomy be performed. This author describes cases of recovery after two and a half to three litres of blood have been removed by operation.

Treatment.—1. *Prophylaxis.*—Rough palpation or percussion should not be employed in the cases of rapidly developing enlargement of the spleen, especially if the enlarged organ gives rise to a subjective sense of fulness or pain and tenderness. It seems almost unnecessary to emphasize the danger attending the introduction of an aspirating needle into the spleen.

After falls or blows over the spleen, especially in those with acute splenic enlargement, prophylactic treatment is indicated at the earliest possible moment to minimize the danger of hemorrhage. The patient should be kept absolutely quiet and a large ice bag applied to the splenic region. Unnecessary physical examinations are contraindicated. Opium is to be given in sufficient doses to ensure bodily and mental calm, and quinine is to be pushed to the point of well-marked cinchonism.

2. *Therapeusis.*—At the time of actual rupture the therapeutic measures at our command are powerless in limiting the hemorrhage or in remedying the damage done. As a routine procedure, however, an ice bag should be applied over the spleen and several quarts of ice water injected as high as possible into the colon. The cold enemata are considered serviceable by Mosler, not only because of the local effect of the cold in checking hemorrhage, but chiefly because of the compression which a large quantity of water in the splenic flexure would exert upon the spleen itself. The collapse and the symptoms of acute anæmia are to be controlled by the customary modes of treatment. The question of laparotomy naturally arises, and, although the operation has been deemed advisable by such authorities as Mayer and Nussbaum, we have as yet but little practical experience to guide us. It would seem as if operative interference was indicated in those cases in which the spleen was apparently healthy at the time of rupture. It is certain that extensive blood changes, especially leucæmic, would contraindicate the operation.

AMYLOID DEGENERATION OF THE SPLEEN; WAXY SPLEEN; LARDACEOUS SPLEEN.

The commonest cause is prolonged suppuration, especially of bone, occurring with the greatest frequency with phthisis pulmonalis and late syphilis. Syphilis may induce amyloid degeneration if attended by advanced cachexia, without necessarily being accompanied by suppuration. Chronic malarial poisoning, chronic diarrhœa, alcoholism, and occasionally slowly-growing malignant neoplasms may give rise to the degeneration.

Although a certain chronicity of the primary cause is necessary for the development of the degeneration, Cohnheim found, in his experience during the Franco-Prussian War, that four months of suppuration might suffice.

Among the organs of the body subject to amyloid change the spleen stands pre-eminent. Hoffman in 80 cases of amyloid degeneration found the spleen affected in 92.5 per cent., the kidneys in 84 per cent., the intestines in 65 per cent., the liver in 62.5 per cent.

The spleen is usually affected early in the course of the suppurative or other primary disease, and may be the only organ that suffers for a considerable time. The cases in which the other organs are attacked while the spleen remains unaffected are much more rare.

Pathological Anatomy.—Small degrees of amyloid degeneration

may exist without apparent change in the appearance of the spleen; the degeneration, however, can be readily demonstrated by microscopical examination with the aid of the well-known reagents which yield characteristic reactions for amyloid material.

More pronounced degrees of waxy degeneration give characteristic appearances to the spleen, which can readily be recognized, and according to visible changes in the organ two varieties of the lesion are described: (1) Sago spleen, (2) diffused amyloid spleen.

1. *Sago Spleen.*—In this form the degeneration is almost entirely, if not exclusively, confined to the glomeruli. The spleen may or may not be enlarged. Upon section the cut surface of the organ is sprinkled with pearl gray, translucent bodies, usually of the size of a pinhead, which closely resemble grains of boiled sago. These bodies represent the degenerated glomeruli. In the centre of many of the bodies may be seen a smooth grayish point corresponding to the cut section of the degenerated afferent artery, and about the glomerulus an area of hyperæmia is usually evident.

The degeneration is confined to the walls of the arteries, capillaries, and to the reticulum of the glomerulus, with atrophy and disappearance of the lymphoid cells. The reticulum of the pulp is usually unaffected; in rarer instances it may become involved.

2. In the *diffused amyloid spleen* there is not only degeneration of the glomeruli, but of the bloodvessels and of the reticulum of the pulp as well. The degeneration may attack the spleen in patches or it may be more or less uniformly distributed.

The spleen is much enlarged, so that in advanced cases the organ may occupy nearly the entire abdominal cavity. Its edges are rounded and hard. The consistence of the organ is increased, and it becomes tough and waxy. Its substance is easily cut with the knife into thin even sections, which are semi-translucent when held to the light.

It has been a matter of some dispute as to whether the sago spleen represents an earlier stage of the more diffused process. At the present time no decided opinion upon this point can be expressed, but the general impression seems to be gaining ground that such is not the case. It is unknown, however, why in some cases the sago spleen should develop, and why in other instances the degeneration is more generally distributed.

Symptoms.—As amyloid degeneration of the spleen seldom occurs by itself, but usually in association with similar degeneration of other organs, and, moreover, as the clinical course of these amyloid degenerations is complicated by the existence of the primary disease underlying them all, it becomes a difficult matter to ascribe any of the symptoms presented by the patient, with any certainty, to the spleen.

Anæmia and cachexia are usually well marked, but their diagnostic significance is lost from the fact that the primary disease is usually of a severely debilitating character. The only direct symptoms referable to the spleen are—(1) pain, (2) sense of weight and fulness, and (3) pressure symptoms.

Pain is not a common symptom. It occurs only in those cases in which the capsule becomes implicated by an inflammatory process. As perisplenitis does not directly complicate amyloid spleen, but rather the

primary suppurative or septic disease, pain cannot be said to be a regular symptom of waxy spleen in the strict sense of the word.

The patient is apt to complain of a sense of weight and dragging, referred to the splenic region. These sensations depend upon the extent to which the spleen becomes enlarged and upon the activity of the patient, being more pronounced in those who are obliged to do active work and heavy lifting.

Pressure symptoms depend upon the size of the organ and upon whether it becomes displaced or remains fixed in its normal situation. The symptoms are those commonly observed in wandering spleen.

Diagnosis is made when under circumstances favoring amyloid degeneration a hard, symmetrical enlargement of the spleen is appreciated, which cannot otherwise be explained. If amyloid degeneration of other organs be present, the diagnosis can be made with reasonable certainty.

Prognosis is generally unfavorable, although the course of the disease is indefinite and may extend over years. The prognosis depends more upon the condition of other organs than upon that of the spleen itself. In many instances the prognosis is that of the primary suppurative disease. It is probable that incipient degeneration may be checked, or may even disappear entirely, if the primary cause be removed in suitable time.

Treatment.—There is no known treatment for amyloid changes of visceræ, except in the way of prophylaxis. All suppurative processes should receive prompt surgical attention. Especially is this demanded in the case of old sinuses of bone. When amyloid degeneration appears a general tonic treatment should be enforced, the patient should be built up, and the strength supported in every possible way.

ANEURYSM OF THE SPLENIC ARTERY.

Pathological Anatomy.—Aneurysm of the splenic artery is of rare occurrence, and the cases reported in literature are so infrequent that very few facts as to the etiology and pathology are at our disposal. It is probable, however, that in some instances the primary cause has been found to be a round ulcer of the stomach at the lesser curvature, which, becoming adherent at its base to the splenic artery, weakens its wall and then allows of its sacculated dilatation.

Sharkey reports a case in which a mass two and a half inches in diameter was found pushing forward the posterior wall of the stomach near the cardiac end. Over this projection into the stomach was found an ulcer three quarters by one half inch in measurement. The ulcer opened into the mass, which was found to be a false aneurysmal sac partly filled with laminated fibrin. The splenic artery opened throughout its entire calibre into this false aneurysmal sac.

West reported a case in which an ulcer of the stomach one inch in diameter was found midway between the pylorus and the œsophageal opening. An aneurysm of the splenic artery was found adherent to

the wall of the stomach at this point, rupturing through the floor of the ulcer.

The size of the aneurysm rarely exceeds that of an orange, and the sac is usually adherent to the stomach and transverse colon.

Symptoms.—The condition may remain entirely unsuspected until the time of rupture. Perforation usually occurs into the stomach or colon.

In Parker's case the patient was in good health, except for slight indigestion and occasional pain in the back, until rupture into the colon occurred and bright blood was passed by the bowel. Death occurred in half an hour. In a case reported by Turner the patient died suddenly while at work and in apparently perfect health. An aneurysm of the splenic artery as large as an orange was found which had ruptured into the peritoneal cavity.

In other cases a pulsating tumor is found which may be distinctly tender on palpation. Pain in the back is but seldom complained of. Leakage through a minute point of perforation may occur, and by the steady leakage blood may be passed by stomach or bowels for several days preceding death. In West's case, already alluded to, the patient gave the history of repeated hæmatemeses, tarry stools, progressive anæmia, and tenderness of the abdomen for ten days. On the tenth day he vomited a pint of bright red blood and died in half an hour.

Prognosis is uniformly unfavorable.

Treatment.—If the diagnosis be made, it may be proper to ligate the splenic artery and even to extirpate the spleen at the same time. No case, however, has been reported in which operative treatment has been employed.

DISEASES OF THE SPLENIC VEIN.

1. Thrombosis of the Splenic Vein.

Thrombosis of the splenic vein may be primary or the conditions may arise secondary to thrombosis of other radicles of the portal system. The iliac and femoral veins are also apt to become involved as an early or late complication.

In a case reported by Rolleston thrombosis of the superior mesenteric vein developed as the result of intestinal ulceration, and the thrombus involved the left external and internal iliac veins, the splenic, and lastly the portal vein itself, in the order enumerated. The principal symptoms of this case were—hæmatemesis, enlargement of the spleen, ascites, and exhausting diarrhœa.

Bonne describes a case in which the splenic vein was involved primarily. The patient, a male twenty-eight years of age, entered the hospital with headache, diarrhœa, enlarged spleen, and anæmia. Abdominal pain soon developed, together with an irregular remittent temperature. Peritoneal friction râles were to be heard over the spleen. Symptoms of perforative peritonitis soon developed, and the patient passed into a fatal coma. At the autopsy bloody fluid was found in the

peritoneal cavity. The splenic vein was obliterated by a thrombus which extended into the smallest branches. In the portal vein a non-adherent clot was found extending into the mesenteric veins, causing an area of necrosis in the small intestine 80 cm. long.

2. Varices.

Cohnheim has reported the case of a male twenty-seven years of age who died suddenly without having given any previous indication of disease.

The spleen was filled with irregular rounded cavities varying in size from that of a pea to a goose egg. The cavities communicated with each other and into the radicles of the splenic veins; the walls showed the structure of normal veins. One of these cavities had ruptured and death resulted from hemorrhage into the peritoneal cavity.

3. Rupture.

Rupture of the splenic vein is of rare occurrence. Atkinson reports a case in which sudden death followed traumatic rupture of the gastro-splenic omentum and its bloodvessels. Melling encountered a case of rupture of the splenic vein from violence.

PERISPLENITIS.

Etiology.—The serous coating of the spleen bears the same relation to that organ that the pleura does to the lung, and consequently participates in many of its inflammations.

Acute perisplenitis is commonly observed with splenic infarctions, abscesses, cysts, and new growths, and may occur as a complication of acute hyperplastic splenitis. The condition also occurs as part of a general or local peritonitis, and may thus be due to ulcer of the stomach, intestinal ulcerations, perinephritis, or suppurative processes of the left pleural cavity.

Chronic perisplenitis may follow the acute variety, may be part of a chronic general or local peritonitis, and complicate many cases of chronic indurative splenitis.

Chronic perisplenitis is a common condition at the autopsy table in cases to which no adequate cause can be ascribed; it is possible that in some of these cases alcoholism or syphilis sustains a causative rôle.

Pathological Anatomy.—The pathology is that of inflammation of the peritoneum in general. In acute cases the perisplenic peritoneum is congested, lustreless, and may be coated with a pellicle of fibrin and pus of varying thickness. If the exudation be abundant and if adhesions to neighboring structures are formed, encapsulation of the exudate may occur.

In the chronic form the peritoneum covering the spleen is more or less irregularly thickened by connective tissue, and the spleen usually

becomes densely adherent to adjacent structures. Calcification of the capsule has been known to occur.

In alcoholic and syphilitic subjects localized thickening of the capsule by a dense cartilage-like substance has been frequently observed.

Symptoms.—Pain is an almost regular accompaniment of acute perisplenitis. The pain is referred to the spleen, and is intensified by deep breathing, by straining, or by lying on the left side. The pain may remain localized or it may radiate to the left shoulder, back, or to the groin. With the pain is usually associated extreme tenderness.

While moderate degrees of splenic pain may arise from overstretching of the capsule in rapid enlargements of the organ, severe pain is almost certainly indicative of the implication of the serous coating in an inflammatory process. The absence of pain, however, does not necessarily exclude perisplenitis, as in many instances merely a pressure feeling is experienced. Fever may or may not be present. If it occurs, it is hard to say how far the primary disease and how far the perisplenic inflammation are responsible for its development.

Upon physical examination the characteristic peritoneal friction râles are heard. These are usually audible from the eighth to the tenth rib and as far forward as the anterior border of the spleen, and are generally more pronounced during inspiration. They are not heard if the diaphragm be paralyzed or if the spleen be adherent.

Palpation may reveal a friction fremitus that is quite characteristic of exudation on serous surfaces. If the exudation be encapsulated, palpation may reveal surface irregularities of the organ.

Adhesions may be confidently assumed when a palpable spleen does not descend during inspiration, or when, after perforative peritonitis, splenic dulness remains unchanged.

The diagnosis of perisplenitis is made with difficulty in many instances from pleuritic inflammation extending into Gerhardt's complemental space. In perisplenitis there is less intensification of the pain during inspiration, the râles are larger and softer and less superficial in character, while pulmonary symptoms are absent.

Treatment of perisplenitis is that of acute localized peritonitis. The bowels are to be kept freely open by saline laxatives, and the patient is to be confined to bed upon a liquid diet. The most efficient treatment consists of the continuous application of cold over the splenic region, preferably by means of the ice bag.

DISEASES OF THE PANCREAS.

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By CHARLES G. STOCKTON, M. D.

Introduction.

Formerly there were held certain positive notions regarding functional disorders of the pancreas, but more definite knowledge of the physiology of the gland has shown the fallacy of the old ideas. It also has shown that it must be most difficult to recognize these functional disturbances, granting that they occur and that they may be important.

This difficulty results from the fact that the pancreas has no function especially and solely its own, and that it shares with the salivary glands, the stomach, the intestines, and the liver the important rôle that it plays in the primary digestion. That functional disorders occur seems probable when the close connection between the pancreas and the sympathetic nervous system is remembered. That these disorders are important seems probable when the serious results that sometimes follow simple atrophy of the gland are recalled. In order to understand the disturbances that might follow functional derangements of the pancreas, and particularly to understand the symptoms that may arise from structural disease of the organ, it is necessary to review some of the results of experiments upon animals and the observations made upon cases having definite lesions.

The pancreas secretes ferments that possess the power respectively of converting starch and sugar into glucose, peptonizing albumin, emulsifying and splitting fats, and coagulating casein. These ferments exert a marked effect in advancing the digestion begun by the secretions of the salivary glands and furthered by the action of the stomach. Besides this, the pancreatic juice seems to lend activity to the lacteals and to modify the glycogenic function of the liver. Furthermore, there is accumulating evidence to substantiate the ingenious theory of internal secretion propounded by Lepine. By a process of hydration the pancreas delivers to the blood that filters through it a glycolytic ferment, and perhaps other substances required by the blood in its office of purveyor to the cells.

Schafer accounts for the internal secretion of the pancreas by the peculiar structure of the gland. Besides the usual secreting alveoli and ducts, there are found patches of a peculiar epithelium-like tissue

characterized by extreme vascularity. They seem to be in no way connected with external secretion, and Schafer believes that this structure supplies to the blood the substance required to complete the digestion of carbohydrates, and that in the absence of this peculiar action of the pancreas glycosuria appears. The fact that the pancreatic juice has been diverted from the intestine by means of a fistula, as practised by Schiff in 1872, without producing glycosuria or other serious disturbances of the animals, lends proof to this doctrine.

Chauveau and Kauffman conjectured that this inhibiting effect of the pancreas was accomplished by influencing hypothetic "sugar centres" in the bulb—a position not generally accepted.

Elliotson, Recklinghausen, and others have found diabetes in cases of cystic disease obstructing Wirsung's duct from calcareous depositions.

Frerichs, Seegen, and many others have observed glycosuria in atrophy of the pancreas. This symptom has been produced experimentally on dogs by Minkowski, who concluded that the degree of glycosuria resulting was somewhat in proportion to the amount of the pancreas removed. When, however, a piece of the gland was grafted into the wound, no sugar appeared in the urine, and when the graft was removed, the glycosuria appeared. W. Sondenmeyer confirmed these results. Minkowski suggests that the pancreas in some way enables the organism to make use of the glycogen, and hence that when the gland is removed glycæmia develops.

There have been a few cases in men and animals where the functions have gone on undisturbed although the pancreas was apparently destroyed. The bulk of testimony goes to show that complete extirpation of the pancreas is succeeded by glycosuria, if not by diabetes.

The experiments of T. O. Schobad, while they confirmed this conclusion, also appeared to show that the loss of a small portion of the organ led to polyuria. Ligature of the duct of Wirsung, while it did not produce glycosuria or polyuria, led to the appearance of large amounts of fat in the stools.

Fatty Stools.—The phenomena of fat in the stools has long been recognized. It occurs in the form of lumps resembling tallow, as semi-fluid fat like butter, as liquid fat mixed with and deposited upon the fæces, and in the form of fat crystals.

Early in the century attention was called to the presence of fatty stools in pancreatic disease. The importance of this symptom came to be exaggerated through the experiments of Bernard, who found fat in considerable quantities in the fæces of animals who had suffered a loss of the pancreas.

Further observations showed, however, that in many instances of pancreatic disease fat was not present in the evacuations, and further experiments showed that the entire gland might be removed from the animal and yet have the stools remain free of fat. How this contradiction may be explained is not determined. Lipuria, sometimes accompanied by glycosuria, has been reported in several cases where the pancreas was diseased.

Albuminoids Undigested.—Fles has drawn attention to the presence in the stools of large amounts of muscle fibre in pancreatic disease. The important action of trypsin upon proteids is possible in an alkaline

or neutral medium only. As the albuminoids are largely digested in the stomach, and as an abundant flow of bile is necessary to alkalinize the intestinal contents before the ferment may be active, the mere presence of undigested proteids in the stools offers but moderate information as to pancreatic activity. Excess of proteids in the stools is often but a symptom of too active gastro-intestinal peristalsis.

When, in a given case, by examination of the stomach contents, an approximate idea can be formed of the extent of digestion exercised by the gastric juice upon muscle fibre, more definite knowledge may be derived from study of the fæces. As trypsin is active only in an alkaline medium, the evidence as to biliary secretion must be considered. In other words, if the stomach exerts only a feeble action on muscle fibre, and if there is evidence in the stools of an ample biliary secretion, and if diarrhœa is absent, the presence of large quantities of undigested muscle fibre is indicative of insufficient pancreatic secretion. The observations of Lea, as verified by Chittenden, show that in natural pancreatic digestion leucin and tyrosin may be found in considerable quantities. In their decomposition skatol, phenol, and indol appear.

It has been suggested by Lea that in case of an epigastric tumor, if there should appear merely a slight reaction to indican in the urine, it would point toward a pancreatic growth, for the reason that marked indicanuria is commonly present in gastric and intestinal tumors. The inference is ingenious, but wider experience in the study of indicanuria shows that it occasionally is absent in gastric carcinoma as well as other abdominal growths.

The excess of indican seems to depend more upon the presence of intestinal bacteria than upon the activity of the pancreas. The test of failing pancreatic secretion recommended by Mucki would seem to possess value. It depends upon the fact that salol is decomposed in the bowels by an action of the pancreatic juice into salicylic acid and phenol. The latter escapes through the kidneys as a sulphocarbolate, and may be recognized by the characteristic dark brown color that it imparts to the urine. If one drachm of salol, in divided doses, is taken during twenty-four hours, and the urine thereafter fails to show the carbolic discoloration, it is a presumptive evidence that the pancreatic secretion is diminished. Fitz regards this sign, together with the appearance of an abundance of undigested muscle fibres in constipated stools after a meat diet, as the most conclusive evidence of the arrest of pancreatic secretion.

Emaciation.—Friedreich observed that uncomplicated cancerous affections of the pancreas in which there has been great emaciation are by no means rare. It is natural to attribute the progressive loss of flesh to this cause when the rôle of the pancreas in digestion is recalled, but it must not be forgotten that great emaciation is a symptom of other abdominal affections; and it is true that patients have died of obstructive and other diseases of the pancreas, some of which have shown an absence of emaciation and others have been positively corpulent. The greatest emaciation seems to occur in those cases in which the flow of bile is interfered with.

Vomiting.—Persistent vomiting often occurs in acute pancreatitis, and sometimes in chronic structural disease of the pancreas. The precise explanation of this is not given. It has been suggested that it may arise from implication of the abdominal sympathetic nerves. Of course when the disease involves the stomach or intestine the explanation is apparent. The belief that a great flow of pancreatic secretion is vomited, or that this excessive secretion leads to a special form of diarrhœa, appears to be an unproved assumption.

Salivation.—Of some diagnostic importance is the flow of large quantities of saliva. This is supposed to be the expression of a sympathy existing between the pancreas and the salivary glands. The relationship is not proved, and the symptom is so inconstant that, occurring alone, it cannot be accepted as a definite indication of disease of the pancreas.

General Consideration.—There appears to be a close relation between the activities of the pancreas and the other digestive organs. Gad and Ratchford found that if the digestive strength of the pancreatic juice is represented at 20, the addition of dilute hydrochloric acid reduces it to 13, while the addition of the principal constituent of the bile increases the digestive activity to 44. When hydrochloric acid and the glycocholate of sodium were both added the digestive strength rose to 56, whereas when bile was added instead of glycocholate of sodium, the activity reached 80.

Vasiliene found that any one of the pancreatic ferments might be made to show a relative increase or decrease as compared with others by varying the diet. In other words, the relative proportion of the ferments depends somewhat upon the nature of the food, proteids increasing the peptonizing ferments and diminishing the amylolytic ferments, and *vice versâ*.

Becker in 1893 ascertained that alkaline fluids depressed the secretion of pancreatic juice; pure water increased the flow; and water charged with carbonic-acid gas not only stimulated the flow of pancreatic juice, but also the proportion of the trypsin. Becker seems to think that these results are dependent upon the rapidity with which the carbonated waters are absorbed. The more rapid the absorption, the more the secretion is stimulated. Several observers have noted that the act of vomiting leads to the suppression of pancreatic juice.

Rupture of the Pancreas.

Rupture of the pancreas is a somewhat rare occurrence and results from traumatism. Its infrequency probably depends upon the deep-seated position of the gland. According to Leith of Edinburgh, rupture of the pancreas seldom occurs unassociated with injury of other abdominal viscera.

Etiology.—Rupture of the pancreas usually occurs from force applied over a very limited area in the epigastrium and directed downward in the median line toward the pancreas, where it lies over the unyielding vertebral column.

Pathological Anatomy.—The rupture of the gland may be slight or extensive. Hemorrhage usually occurs. Many believe that slight

injuries of this character are largely responsible for subsequent pancreatic cysts.

SYMPTOMS, DIAGNOSIS, AND PROGNOSIS.—The chief symptoms, collapse and shock, appear immediately, and are probably due to hemorrhage and to pressure upon the sympathetic ganglia. In none of the reported fatal cases have there been evidences of external injury.

A positive diagnosis is practically impossible without a laparotomy. While always grave, a fatal result need not necessarily ensue. Death may take place from shock, hemorrhage, or succeeding inflammation. If the patient survives the rupture, the development of a retention cyst is to be expected.

TREATMENT.—Rest in bed, the application of ice, and the administration of stimulants and opium constitute the appropriate treatment for the collapse, pain, hemorrhage, or inflammation following injury in this region. An exploratory incision and other surgical procedures may be demanded.

CYSTS OF THE PANCREAS.

ETIOLOGY.—There are various processes described under this head. Formerly the true pancreatic cyst was believed to be a retention cyst occasioned by an obstruction to the duct of Wirsung. Cysts of this nature are known to result from calculi, foreign bodies, or pressure from new growths arising within or without the pancreas. More recent study has discredited obstruction of the principal excretory duct as the cause of ordinary pancreatic cyst. Aside from a few instances of cystoma of the pancreas which some have supposed to be malignant in nature, the drift of opinion is toward traumatism as the source of cysts of the pancreas.

Krecke, in his summary based on published cases, concluded that traumatism is the only cause that can be established with certainty. This writer believes that it is not impossible that the extension of gastro-intestinal catarrh into the ducts of the pancreas may excite local obstruction and cystic formation.

Friedreich believes that closure of the branch ducts by pressure from localized chronic interstitial inflammation may give rise to retention cysts.

Kuhlankampff accounts for the disease by injury that causes inflammation of the gland substance which leads to closure of branches of the duct and consequent retention. This view Senn formerly held, but found that it was not verified by experimental work on animals. He concluded that the cyst might be formed in various ways: First, by hemorrhage into the pre-existing pancreatic cyst; second, parenchymatous hemorrhage producing a cyst, followed by hemorrhage into the cyst wall; third, by dilatation of one of the bloodvessels in the pancreas. The second of these methods seems the most probable, and has received the support of Cathcart, Lloyd, and Leith. Cathcart explains that the laceration of the gland following trauma is succeeded by an extravasation of blood, which blends with the secretion that leaks through the torn pancreatic ducts. From the effusion of blood and pancreatic secretion into the spaces caused by small ruptures of the gland the cystic tumor begins, and gradually increases in size, owing to

the pouring in of more secretion and to the occurrence of hemorrhage from the cystic walls. He accounts for the capsule as a result of the irritating character of the fluid. If a pancreatic cyst can form in this way—which view is generally adopted—it seems probable that such an event might follow spontaneous hemorrhage into the substance of the pancreas, finally leading to rupture of some of the pancreatic ducts.

Not infrequently cysts occur about the pancreas in the lesser omental cavity, sometimes including the pancreas in their growth, and sometimes quite distinct from it.

Leith collected from literature 17 cases of pancreatic cyst following traumatism. It is not possible to say that all of these were true pancreatic cysts. A few of them were verified by examinations of the fluid contents. The shortest period of development was ten days and the longest eight years after the trauma. The usual time of appearance is between two weeks and four months after the injury.

Symptoms and Diagnosis.—The earlier symptoms of pancreatic cysts are disturbance of digestion and colicky pain or other unnatural sensations in the region of the gland. Remondino reports having seen excessive salivation as a symptom in several cases. The appearance of the tumor, however, is the chief evidence of the growing cyst. Its location will depend somewhat upon the part of the gland involved. It is a retroperitoneal, fluctuating tumor, generally presenting forward between the stomach and the transverse colon, somewhat to the left of the median line if the cyst should arise in the tail, and somewhat to the right of the median line if the cyst should arise in the head of the pancreas. In the latter instance the dulness over the tumor would be continuous with that of the liver. It is usually a spheroid, elastic body, dull on percussion and separable from the liver dulness by a zone of resonance.

Fluctuation is not usually discovered in the beginning, but appears when the cyst is large and near the surface. By inflation of the stomach and transverse colon it may be shown that the cyst lies behind these organs. When the cyst is large it may be differentiated from ovarian cyst by the fact that it appears in the upper abdomen. It may be differentiated from hydronephrosis, as the latter is found more to one side ; from aneurysm of the abdominal aorta in the facts that the pain is of a different character, and that, while the tumor may transmit the pulsation from the aorta, the expansile sensation belonging to aneurysm is absent. A dilated gall bladder may be excluded because of its position far to the right, and also by the nature of its contents on aspiration.

The fluid of the pancreatic cyst is usually dark brown in color, showing blood elements, and, if the case is not of too long standing, the digestive ferments peculiar to the pancreas are present. These facts enable one to differentiate between the pancreatic cyst and the echinococcus cyst or the inflammatory cysts of the peritoneum.

The pancreatic cyst often lasts for years without causing any serious inconvenience. Occasionally it ruptures into the abdominal cavity, producing peritonitis, or it may rupture into the stomach or intestines, in any of which events death would doubtless follow. Middleton reports a case terminating in necrosis of the pancreas and fat necrosis.

TREATMENT.—As for treatment, aspiration has not proved a success, as the cyst invariably refills. Laparotomy is to-day usually resorted to, and the cyst brought forward to the abdominal wall, emptied, and drained. In the 17 cases collected by Leith all were successful with 1 exception. Occasionally fistula follows, although this is usually corrected by time.

PANCREATIC COLIC AND PANCREATIC CALCULI.

Pancreatic colic may result from pancreatic lithiasis or either one may exist without the other.

ETIOLOGY.—Pain of a colicky nature occurs in various forms of pancreatic disease; and severe colic, suggesting by the character of the pain hepatic colic, may result from the passage of pancreatic calculi or from other temporary obstruction of the canal of Wirsung. The origin of calculi of the pancreas seems to rest partly upon catarrhal inflammation of the pancreatic duct and its branches, and partly upon the peculiar state of the pancreatic secretions. This condition of the secretions probably results from some blood dyscrasia. A dilatation of the canal sometimes precedes formation of the calculi, and, on the other hand, a calculus obstructing a duct may give rise to that form of dilatation aptly named, by Virchow, "ranula" of the pancreas. In dilatation of the pancreatic duct and its branches the formation of calculi is made easy, as the salts from the secretion are precipitated, while the fluid is, in a measure, absorbed. Nevertheless, there are sometimes seen dilatations of this character without calculus.

PATHOLOGICAL ANATOMY.—The theory that so-called pancreatic colic was the direct result of the passage of a calculus for a long time rested upon a slender basis. The number of cases now collected establishes the doctrine on a sound pathologic foundation, although it is not a very common event.

Cases are described by Holzman showing glycosuria and salivation, accompanied by nausea and severe colic. Several cases are reported where glycosuria has occurred during a paroxysm of pain, and where, subsequently, calculi have appeared in the stools. And, finally, there are cases presenting the history of colic succeeded by the passage of calculi, and at the post-mortem there were found concretions in the pancreas, with the usual atrophic changes that follow obstruction.

The calculi are white or grayish in color, sometimes dark or almost black. They vary in size from that of fine sand to that of walnuts. They are usually round, but occasionally take on irregular shapes, sometimes branching, sometimes having rough surfaces. The concretions are sometimes held fast in branches of the canal; occasionally a large calculus is found in the tail of the pancreas. As a result of obstruction the canal dilates, and the parenchyma of the pancreas undergoes atrophy from pressure and loss of function. When the canal is dilated its branches may stand out prominently on the surface of the atrophied gland. This is sometimes associated with increase of interstitial tissue, which change may be sufficient to lead to enlargement and induration of the pancreas.

SYMPTOMS.—The symptoms of pancreatic colic are pain in the

region of the umbilicus associated with sugar in the urine, and possibly fatty stools and the other symptoms of obstruction hitherto described. Upon examining the evacuations the calculi may be discovered composed of carbonate or phosphate of lime. Generally the symptoms of calculi of the pancreas are not to be separated from the symptoms of other chronic pancreatic disease. The appearance of glycosuria, fatty stool, and the passage of large amounts of muscle fibre undigested are among the most important symptoms, but they do not belong alone to the history of calculus of the pancreas.

Prognosis.—When the diagnosis can be reached the prognosis of the affection must depend largely upon the extent of the glycosuria and other symptoms of atrophy or cystic change of the gland.

Treatment.—The administration of pilocarpine has been successful in relieving several cases of supposed pancreatic colic. Nothing is definitely known as to the prevention or treatment of stone of the pancreas, but it seems highly probable that the same measures that succeed in obviating concretions in the kidneys and biliary passages would succeed in cases of the pancreas. These include attention to the primary digestion, the maintenance of the proper alkalinity of the blood, the drinking of large quantities of water, the securing of an active capillary circulation and cutaneous secretion, and the improvement of general nutrition by hygienic measures.

Hemorrhage into the Pancreas.

Etiology.—Hemorrhage of the pancreas is not always of the same nature. It may be secondary to dilatation of the right heart and the consequent general venous stasis. At such times hemorrhagic spots are scattered through the pancreas in the interlobular substance, and are usually associated with chronic interstitial changes. As the result of pre-existing vascular disease large hemorrhages may occur into the substance of the pancreas, forming the so-called apoplectic cysts. Hemorrhage may also result from traumatism. In 1874, Zenker described several cases of hemorrhage into the pancreas followed by sudden death. The interest in this subject was advanced in this country by the contributions of Prince and Draper. Although many cases of this form of pancreatic hemorrhage have been collected during the past twenty years, nothing definite is known concerning the cause of the affection. It has been suggested that the hemorrhage may be of nervous origin, as in some cases foci of pulmonary hemorrhage have been found to accompany that in the pancreas.

It has been thought that erosion of the vessels might be produced by the action of the trypsin on the pancreatic juice under pathological conditions.

Pathological Anatomy.—The hemorrhage may be large or small, appearing in the interlobular tissues or in the subperitoneal tissues, or, penetrating the omental fat, the hemorrhage may appear in the mesentery or retroperitoneal fat. The pancreas may be large, soft, and friable, or its form and consistency may be but little changed. Sometimes the organ is hard from previous interstitial growth, and the hemorrhages may then occur as small spots scattered through the organ. There may

also be a fatty infiltration or degeneration or localized fat necrosis of the gland.

Symptoms and Diagnosis.—Epigastric pain is usually present, sometimes slight, but generally intense, and accompanying this is the appearance of shock and a feeling of impending death. Vomiting is frequently and diarrhœa exceptionally present. The most important symptoms, shock and circulatory failure, may be accounted for by pressure upon the semilunar ganglion, the solar plexus, or upon their branches, occasioned by hemorrhage into and around the pancreas. Diagnosis of the affection, if made, must be based upon the criteria described.

Prognosis.—It is known that recovery takes place from small pancreatic hemorrhages, since remains of preceding hemorrhages may be found in the organ when death results from another cause. Sudden death is a frequent result, and life may be terminated almost instantly by shock, or, where it is not so severe and where remedies are promptly applied, the result may be delayed or averted. Cases beginning with moderate hemorrhage are apt to proceed to inflammation and death from acute pancreatitis.

Treatment.—The treatment is limited to absolute rest, stimulants, opium, and the local application of ice.

Acute Pancreatitis.

To Fitz must be accorded the credit of having placed the acute inflammatory affections of the pancreas on a secure pathological and clinical foundation. He pointed out that acute pancreatitis is a well-characterized disease occurring more frequently than had been supposed. The classification suggested by Fitz has withstood criticism, and there are now usually described three forms—hemorrhagic pancreatitis, suppurative pancreatitis, and gangrenous pancreatitis. The hemorrhagic and gangrenous forms are sometimes closely related.

Acute Hemorrhagic Pancreatitis.—The process resembles diffuse hemorrhage into the pancreas, but has in addition the pathological changes belonging to acute inflammation.

Etiology.—It has been stated that when hemorrhage occurs into the substance of the gland it is followed by inflammation in a certain proportion of cases. It is known that traumatism stands as an occasional cause of pancreatic hemorrhage, and must therefore be considered as a factor in producing pancreatitis. Chronic alcoholism appears to predispose to the disease, probably by lowering the immunity to microorganisms that invade the gland through its excretory duct or through the channels of the circulation.

The most common cause of the disease is believed to lie in the extension of inflammation from the duodenum to the pancreas through Wirsung's duct.

Pathological Anatomy.—The gross appearance of the pancreas will depend somewhat on previous interstitial changes in the gland, and partly on the extent and method of the hemorrhage. The gland may be dense and but slightly enlarged, owing to previous increase of the stroma. At other times it may be large, soft, and dark colored from

the presence of hemorrhage. Blood may appear in the subperitoneal tissues, following the course already described.

On section the gland may present a uniform dark red appearance, and there may be small points of hemorrhage scattered through the organ, together with streaks and patches of whitish yellow, opaque matter from the presence of fat necrosis.

The inflammation is usually diffuse, and the exudation is hemorrhagic, cellular, and fibro-cellular, and the lobules are in a state of coagulation necrosis. In the peripancreatic fat tissues an abundant round-cell infiltration is often seen, and disseminated fat necrosis is common, particularly in the vicinity of the diseased organ. Bacteria are sometimes present in large numbers, both within the inflamed pancreas and in the surrounding necrotic matter.

Symptoms.—As the onset of pancreatic hemorrhage is sudden and severe, so is the beginning of hemorrhagic pancreatitis.

There is usually the presence of shock and intense epigastric pain without obvious cause. In most cases this is succeeded by nausea and vomiting, with great tenderness on pressure over the epigastrium, constipation, and moderate tympany. The patient may go at once into collapse, or, after continuing for a time in great prostration with low fever, may improve, and even recovery is possible. While admitting that this course may be followed, a continuance of the disease is much more probable, and the patient, with somewhat milder symptoms, eventually dies of what appears to be subacute peritonitis.

Diagnosis.—The diagnosis must be based upon the sudden appearance of pain and tenderness limited to the region of the pancreas, and upon the gradual development in this vicinity of a deep-seated peritonitis. It may be differentiated from perforating ulcer of the stomach or of the intestine by the absence of the characteristic history. Besides, in perforating ulcer the peritonitis is usually more general and more rapidly progressive. By the absence of jaundice biliary colic may be excluded. It is more likely to be mistaken for irritant poisoning or acute intestinal obstruction. The former may be excluded by the history of the case and by the examination of the stomach contents, and the latter by determining that the large intestine is patulous and by the absence of marked general tympany or distentions of limited portions of the intestines. Furthermore, although constipation is the rule at first, diarrhœa sometimes occurs, and at other times the bowels may be successfully opened by purgatives.

Prognosis.—From information gained both by ante-mortem and post-mortem explorations there is reason to believe that in some cases of hemorrhagic pancreatitis patients recover. The affection is apt to pass into a gangrenous pancreatitis. All severe cases may be expected to end fatally unless helped by surgical intervention.

Treatment.—As in hemorrhage, in the beginning the treatment should be absolute rest, morphine hypodermically, and the local application of ice. At this time surgical procedures are dangerous, but later, when the gland becomes gangrenous or when there is extensive fat necrosis, an abdominal section would be indicated.

Acute Gangrenous Pancreatitis.—Etiology.—A certain proportion of cases of hemorrhagic pancreatitis terminate in a gangrenous

process. The etiology of gangrenous pancreatitis rests primarily in the causes of the hemorrhage. The development of the gangrene is not satisfactorily explained. It should be noted that the change known as the fat necrosis of Balser is in some cases conspicuous in the substance of the pancreas and also as a disseminated fat necrosis. Marchiafava thinks that in the peripancreatic and pancreatic fat necrosis we have a separate disease with a special pathology.

PATHOLOGICAL ANATOMY.—The change in the pancreas from a state of hemorrhagic inflammation into a state of gangrenous pancreatitis begins within a few days, and rapidly extends throughout the gland and surrounding tissues. The pancreas is black or slate colored, soft or even oozing. It is slightly attached by a few filaments or sequestrated, and is immersed in a pool of sphacelated, liquefied tissue and necrotic fat enclosed in the lesser omental cavity. This mass may find its way downward into the pelvis or it may discharge itself into the stomach or intestine. The remnants of the pancreas have thus been known to escape.

General peritonitis is not a usual accompaniment, but disseminated fat necrosis is common. Secondary infectious processes in the liver, spleen, lungs, and brain may follow.

SYMPTOMS.—The early manifestations are those of hemorrhagic pancreatitis of moderate severity. After four or five days symptoms of toxæmia and peritonitis develop. Through a thin abdominal wall may be felt induration in the region of the pancreas, and pain and tenderness upon pressure are always present. There is vomiting, sometimes diarrhœa and great prostration, terminating in collapse after two or more weeks. The symptoms resemble those of subacute peritonitis.

DIAGNOSIS.—The diagnosis of this condition is very important, as early surgical interference is indicated. There is first the sudden attack peculiar to hemorrhage into the pancreas. This is followed by symptoms of deep-seated peritonitis, localized, not of a very acute type, but associated with unusual prostration and evidences of toxæmia.

PROGNOSIS.—A fatal termination has been seen in most cases. Recovery has occurred, the necrotic mass, including the remains of the pancreas, spontaneously escaping. A brilliant diagnosis may lead to good results, as in a case hereafter referred to.

TREATMENT.—During the early days of the disease the treatment must be symptomatic. When destruction of tissue has somewhat advanced relief should be sought by cœliotomy and drainage.

Acute Suppurative Pancreatitis.—This form of pancreatic inflammation seems quite distinct from the hemorrhagic and gangrenous forms just described. Nothing definite is known of its etiology, save that traumatism is believed not to play a part in its production. Abscesses of the pancreas are sometimes of embolic origin. The prevailing opinion is that, for the most part, the disease depends on bacterial invasion from the intestinal tract.

PATHOLOGICAL ANATOMY.—The pancreas is usually large, particularly in certain regions where an abscess or a collection of abscesses may be located. These abscesses may be scattered throughout the entire gland or may be limited to any part of it. There is extensive round-cell infiltration and an increase of fibrous tissue. The changes

are less diffused than those seen in other forms of acute pancreatitis. The ducts and many of the lobules are destroyed by suppurative and fibrous changes, but there are not seen the hemorrhagic and cellular exudation and the extensive coagulation necrosis to be found in other forms of acute pancreatitis. The peripancreatic fat tissues show marked round-cell infiltration. There is quite uniformly a limited peritonitis about the pancreas, and in prolonged cases an abscess of the pancreas is likely to empty itself into the lesser omental cavity. Disseminated fat necrosis is not common in abscess of the pancreas—another point in which it differs from the gangrenous form of the disease.

Symptoms.—The attack is ushered in with acute epigastric pain and deep-seated tenderness in the same region, together with vomiting and prostration. The urine is usually high colored; there is complete anorexia and there may be diarrhœa. After four or five days there appear evidences of suppuration. Chilly sensations or chills, a diurnal elevation of temperature, and sometimes sweating, are characteristic symptoms.

In suitable cases there can be determined by deep palpation an indurated mass in the region of the pancreas, sometimes movable and occasionally giving rise to a sensation of fluctuation. The abdomen is usually tympanitic over this part; at other times dulness may be elicited on percussion. Jaundice, with its characteristic symptoms, is sometimes present at this time. The course may be rapid or it may be prolonged and subject to periods of subsidence and accession in the symptoms. There is progressive emaciation and debility. The immediate cause of death is septicæmia or peritonitis.

Diagnosis.—Sudden severe pain in the region of the pancreas, followed after a few days by symptoms of suppuration, with localized tenderness and induration, are the most important diagnostic symptoms.

Prognosis.—So far as known, the disease has always proved fatal. By surgical treatment at a comparatively early stage of the process it would seem probable that recovery might follow in a fair proportion of cases.

Treatment.—Aside from surgical measures, the treatment is purely symptomatic and expectant. As a further acquaintance with the disease leads to earlier and more definite diagnosis, much relief may be gained by the same surgical measures recommended in other forms of pancreatic disease.

Disseminated Fat Necrosis.—With certain diseases of the pancreas, particularly in hemorrhagic and gangrenous pancreatitis, there is often associated a more or less marked fat necrosis, occurring in the interlobular fat tissue of the pancreas, and also extensively in the abdominal fat, particularly in that disposed about the pancreas. This fat necrosis, first described by Balser, is accompanied with inflammatory and hemorrhagic phenomena, and most observers have found it only in connection with disease of the pancreas, and usually in fat people. Rolleston reported a case without disease of the pancreas. Minute foci of fat necrosis are frequently found in men and animals. That these have the same etiology as the more extensive process under discussion is not determined. Balser pointed out that areas of fat necrosis are frequently found in the interlobular substance of the pancreas in indi-

viduals who had presented no symptoms of pancreatic disease. Fitz reported a case in which the fat necrosis followed a hemorrhage and pancreatitis the result of injury. Formad in 1892 reported a case of subacute pancreatitis in which foci of fat necrosis occurred universally throughout all the adipose tissues of the body. Hansemann had a case in which the fat necrosis of the subcutaneous tissues corresponded with a roseola of the overlying skin.

In 1 case reported by Chiari, and in 1 of 2 cases reported by Williams and the writer, widespread fat necrosis appeared with only slight pancreatic changes. In these last-named, quite typical cases the pancreas had lost most of its attachments, was practically sequestrated, and virtually afloat in a pultaceous fluid consisting of opaque masses and granules, highly refracting globules, and needle-shaped crystals. Scattered through the fat of the greater and lesser omentum, through the mesenteric fat, and in one case in the fat of the abdominal wall, were numerous white nodules, some soft and some hard, varying from the size of a milletseed to that of a pea, and a few as large as walnuts. Some of these nodules were very soft, approaching liquefaction, and were evidently undergoing the change seen in the semifluid mass surrounding the pancreas. Frozen sections of these white necrotic nodules showed them to consist of coarse granules, masses, globules, and crystals, such as were described as occurring in the semifluid mass. There were also found in some of these nodules collections of brown pigment. Many nodules seemed to be enclosed in part by a definite connective-tissue boundary, in some instances even to the extent of forming a relatively thick capsule. There was marked cell infiltration of these capsules and, to a less extent, of the underlying part, the cells having good-sized round, oval, or spindle-shaped nuclei. There was moderate congestion of, and a few extravasations into, the surrounding tissues, where the fat cells appeared normal. In other parts the fat cells showed an increased number of nuclei. In some of the necrotic areas remaining, fat cells could be found, also strands of connective tissue. Certain portions of the necrotic areas were soluble in ether, leaving behind an opaque substance soluble in acetic acid and shown to contain a calcium compound.

The congestion, hemorrhage, and cell infiltration indicated an inflammatory reaction about the nodules. The colon bacillus was found in large numbers in the pancreas and a proteus in the necrotic fat, in one case. The colon bacillus was found in the necrotic fat in a case of Welch's, also by Hektoen of Chicago. In most reported cases cultures have proved sterile. Langerhans found calcium in combination with fatty acids. According to this view, which has been abundantly confirmed, the essential feature of the process is the decomposition of the neutral fats, setting free fatty acids. Sarfert reports 3 cases in which, he says, fatty acids were combined with sodium, and not with calcium, as maintained by Langerhans.

Etiology.—The cause of disseminated fat necrosis associated with disease of the pancreas is not satisfactorily explained. The suggestion of Langerhans, that the process may result from the escape of the fat-splitting ferments of the pancreas into the surrounding tissues, is plausible. It is supported by the experiments and conclusions of Hilde-

brand. Williams of Buffalo has succeeded in producing fat necrosis in cats by ligation of one half of the pancreas. He found that the result was not invariable, as fat necrosis sometimes failed to appear. In one case the fat necrosis was so extensive as to entitle it justly to the name of disseminated. This investigator is not convinced that some other agent is not concerned in the process. However, Williams has recently succeeded in producing fat necrosis by introducing bits of sterile pancreas into the subcutaneous adipose tissues of cats. The resulting necroses were found to be sterile. He also suggests that the frequent occurrence of fat necrosis in very stout people may depend upon their having pancreases very active in the formation of the fat-splitting ferment, which might lead to the accumulation of adipose tissue, and also might favor the development of fat necrosis. The views of Hildebrand meet with the approval of Fitz. Rolleston suggested that a nervotrophic change would account for the fat necrosis. With the exception of the observations above described no positive results have followed bacteriological methods.

Diagnosis.—The symptoms of disseminated fat necrosis are those of subacute peritonitis and toxæmia: prostration, pain, vomiting, constipation, moderate tympany, and foul skin are to be looked for.

Prognosis.—Recovery from slight fat necrosis is to be expected. When the necrotic process is widespread and the destruction of important parts is great, death results either from the shock, from the toxæmia, or from both.

Treatment.—A laparotomy, with the establishment of drainage, is the only treatment that offers a reasonable hope of success in an advanced case. It has been tried in few cases, and successfully by Finney in a case reported by Thayer.

Chronic Pancreatitis.

Chronic inflammatory changes of the pancreas arise from different causes and are somewhat unlike in nature. That the processes are not more sharply differentiated is owing to the similarity in clinical history, and often to the absence of symptoms pointing toward the pancreas.

Etiology.—Chronic induration from increase of connective tissue in the pancreas may result from syphilis, chronic arterial sclerosis, or from the chronic congestion of the organ due to venous stasis. A similar result may develop from preceding suppurative pancreatitis, or from chronic inflammation by infection reaching the organ through the secretory ducts. Atrophy of the pancreas, accompanied with chronic inflammatory changes, sometimes follows long-continued obstruction to the duct. Thus this condition frequently develops in connection with calculus of the pancreas. Syphilis is known to induce induration of the pancreas, particularly when it is a congenital affection. It is said that alcohol brings about changes in the pancreas analogous to those seen in cirrhosis of the liver.

Pathological Anatomy.—In induration of the pancreas the organ is often considerably increased in size and weight, due to the growth of fibrous tissue, which is first seen around the ducts and vessels of medium or small calibre. In more advanced cases the interacinous

connective tissue is affected. This may be present equally throughout the gland or it may be limited to certain parts or areas. Sometimes the head is very large and the body and tail small. At other times the body is shrunken and the extremities large. The organ may show but little change in color, and its surface may be smooth or irregular. It is sometimes surprisingly large and cuts with much resistance. Calcareous masses are frequently found in the duct or its branches, which latter may be normal or dilated and irregular in appearance. Occasionally, when the duct is obstructed, the pancreas is found to have undergone marked atrophy, save the duct and its branches, which are dilated and stand out prominently on the surface of the organ. In cachectic states, when from innutrition the heart, liver, and kidneys have undergone a simple atrophy, the pancreas rarely, although sometimes, shows a like change.

SYMPTOMS.—The symptoms of chronic pancreatitis, so far as known, relate to disturbances both of primary and secondary nutrition. That is to say, there are evidences of intestinal indigestion, largely arising from deficiency of pancreatic secretion, and also there are disturbances of nutrition in a further sense, resulting in glycosuria, polyuria, emaciation, and other important symptoms. It must not be supposed that these manifestations of the disease always present themselves. On the contrary, patients sometimes enjoy reasonably good health for a long time and die in accidental disease. In chronic indurative pancreatitis grave symptoms sometimes suddenly develop. In a case of the writer uncontrollable vomiting led to the death of the patient, who had previously suffered but little from the disease, which must have been long present. In this case there were transient glycosuria and albuminuria, although the latter symptom probably resulted from an accompanying degeneration of the kidneys.

TREATMENT.—When a diagnosis can be approximated it would be wise to utilize to the fullest extent practicable the saliva and gastric juice in the processes of digestion. This may be accomplished by a proper selection of food, by requiring painstaking mastication, and by the administration of artificial diastatic ferments, preparations of the uncooked pancreas, and perhaps, when necessary, by assisting gastric digestion. The drinking of carbonated water is said to stimulate pancreatic secretion in health, and this may be of therapeutic use if the disease is not too far advanced.

CANCER OF THE PANCREAS.

Among the most frequent of the structural diseases are morbid growths, and of these by far the most common is cancer. Very rarely sarcomata or lymphomata are found, but their occurrence is esteemed to be remarkable. The disease occurs either as a primary or secondary growth, of which the latter is the more often seen.

ETIOLOGY.—Cancer of the pancreas rarely occurs before the fortieth year of life, and is seen in males nearly twice as often as in females. Nothing further is known concerning the causes of primary cancer.

PATHOLOGICAL ANATOMY.—The most common form of cancer seen in the pancreas is the scirrhous, but the medullary, the gelatinous, and cylindrical-cell forms are also encountered. Primary cancer most

often occurs in the head of the organ, but it may appear in the body or tail. There develops a hard, somewhat irregular, rounded tumor which very frequently obstructs the duct of Wirsung and also the common bile duct. Occasionally the growth is sufficiently large to obstruct partially the duodenum or colon, or it may exercise pressure upon the pyloric extremity of the stomach. Because of pressure upon the aorta a systolic bruit may arise, and a pulsation and thrill may be transmitted through the tumor to the hand of the examiner.

These growths have been known to obstruct the ureter, the portal vein, and the common bile duct, thus giving rise to hydronephrosis, ascites, and jaundice. It is common for primary cancer to attack contiguous parts, and it is particularly common for the duodenum, stomach, and liver to become thus affected. When vascular growths have spread to the stomach or intestine severe hemorrhage may occur.

The secondary cancer may show itself as an isolated growth in the pancreas, occurring as a metastasis from disease in some distant part of the body, but more commonly it appears in the head of the organ, and is secondary to a primary growth in the liver or in an adjacent part of the digestive tract.

Symptoms.—Among the symptoms that are rarely absent in cancer of the pancreas are to be mentioned progressive emaciation, cachexia, excessive weakness, and severe pain in the vicinity of the growth, sometimes paroxysmal in nature, and at times so severe as to become almost unendurable. Tenderness upon pressure is common even before the tumor can be felt. In about 50 per cent. of cases there appear some of a group of symptoms that, although less frequently observed, are highly significant when present: they are fatty stools, glycosuria, and the passage of muscle fibre undigested after meat has been eaten and when diarrhœa is absent. The first of these symptoms, fatty dejections, apparently occurs oftener than in other forms of pancreatic disease. The writer found this symptom present in three instances of cancer of the pancreas, and has never seen it in other diseased conditions of the organ.

The presence of glycosuria will depend upon the extent to which the gland is involved. There is another group of symptoms usually present in the disease, yet so often seen in connection with other affections as to be unimportant. Among these should be mentioned jaundice, disturbance of the stomach and intestine, vomiting, diarrhœa, or constipation.

Diagnosis.—It is only by a combination of favorable circumstances that one is able positively to diagnosticate cancer of the pancreas. When there is found in a patient past middle life progressive emaciation, marked cachexia, severe, often continuous, pain in or just above the umbilical region, and the development of a palpable tumor irregular in shape and tender upon pressure, a provisional diagnosis of cancer may be reached. If, in addition to these symptoms, glycosuria, fatty dejections, or other evidence of disappearance of pancreatic secretion should appear, the diagnosis may be made positive. The salol test has not proved altogether reliable.

Prognosis.—Cancer of the pancreas may follow a rapid course, and death may ensue in a few weeks. In slower-growing tumors a year or more may elapse before the disease reaches its inevitable termination in death.

DISEASES OF THE THYROID GLAND.

DISEASES OF THE THYROID GLAND.

DISEASES OF THE THYROID GLAND (EXCEPTING CRETINISM AND MYXŒDEMA).

By FRANCIS P. KINNICUTT, M. D.

INFLAMMATION OF THE THYROID GLAND; THYROIDITIS.

Acute thyroiditis occurs exceptionally as a primary affection; more frequently it is secondary to general infections, typhoid fever, diphtheria, puerperal fever, and septicæmia of varied origin. It rarely occurs in a gland previously healthy. The inflammation may resolve or terminate in suppuration and abscess formation.

Symptoms.—The symptoms of thyroiditis are those of ordinary inflammatory processes, sensitiveness of and pain in the affected gland, and, if the swelling is great, pressure symptoms, such as often occur in large goitres, may be present. If the inflammation develops in the course of infectious processes elsewhere, the constitutional disturbance already present may be little if at all affected.

In primary thyroiditis the onset may be accompanied by a chill or chilly feeling, followed by a rapid rise of temperature to 103° or 104° F. In case of abscess formation the abscess may open externally or break into the anterior mediastinum, rarely into the trachea or œsophagus, or the pus may become encapsulated.

Treatment.—The treatment consists chiefly in the use of local measures—in the application of the ice bag or hot poultices over the inflamed gland. In abscess formation free incision and drainage should be employed.

GOITRE.

Latin, *guttur*, the throat.

Synonyms.—Bronchocele; Derbyshire neck; Kropf; Struma; Gozzo.

Definition.—It would seem advisable to include under the name goitre only those enlargements of the thyroid gland which are non-inflammatory, non-tuberculous, and non-malignant in character. Hydatid disease of the gland also properly should be excluded.

The not infrequent development of the symptoms of exophthalmic

goitre in cases of goitre of long standing is well known, and a differentiation of goitre from exophthalmic goitre of an ill-defined form often presents many difficulties to the clinician; in the present article, therefore, goitre only as presenting a typical clinical picture will be considered.

Etiology.—Goitre occurs sporadically, endemically, and epidemically. Heredity may be regarded as exercising an influence in the production of the disease, although the subjection of goitrous families to a similar environment renders difficult a just estimate of its potency. The disease is more common in women than in men, and the period of puberty is especially favorable to its development. Congenital goitre has exceptionally been observed. Little that is definite is known in regard to the causes of sporadic goitre. Repeated pregnancies, occupations which favor obstructions of the circulation in the cervical veins, mountain climbing, and carrying heavy weights on the head are regarded as predisposing causes.

The geographical distribution of endemic goitre is widespread. Hirsch[1] states that in addition to the region which has the Alps and its subsidiary ranges as a centre, where the disease exists in maximum severity, there is no country in Europe, except perhaps Belgium, Denmark, and Norway, in which it does not exist, at least in certain districts. In England it is comparatively common. In European Russia it is confined to a few departments, while in Siberia it is widely prevalent. It is also found in the Himalaya districts of Asia, in some parts of India, and in Northern China. In North America it exists in Lower Canada and some contiguous portions of the United States. It has been shown by Munson[2] also to be very prevalent among the Indians of Southern Montana, Wyoming, Utah, Idaho, and Colorado, on the immediate western slope of the Rocky Mountains, and again in the western portions of the Dakotas. Munson makes the interesting statement that the disease is much more common among the tribes living at the base of the mountains than in those living among them; and, moreover, that goitre is relatively very infrequent among the white settlers living on or near the reservations.

In Mexico, Central America, and South America it is endemic over large areas.

There also seems to exist a slow periodic variation in the number of cases in affected localities, and acute epidemic invasions both of these and new localities have been noted.

While the occurrence of cretinism is particularly marked in goitrous districts, yet the two affections do not run precisely parallel in their geographic distribution.

Among the exciting causes of goitre, the drinking water of endemic districts is probably a potent one. Various inorganic constituents of the water, especially magnesia and lime, have been regarded as the disease-producing elements. Kocher,[3] however, who has had exceptional opportunities for studying the disease, believes that the

[1] *Handbook of Geographical and Historical Pathology.*

[2] *N. Y. Med. Journ.*, Oct. 26, 1895.

[3] "Vorkommen u. Vertheilung d. Kropfes in Kanton Berne," *Ein Beitrag. z. Kenntnis d. Ursachen d. Kropfbildung*, Berne, 1889.

exciting cause is to be found in the organic rather than in the inorganic constituents. An interesting observation of his is that in one school in which all the pupils were free from goitre the water used contained four times as much calcium and twice as much magnesium as a "goitrous spring" near by, and that the former contained nine kinds of bacteria and the latter thirty-three. Injections of a mixture of all the germs found in the "goitrous spring" produced a swelling of the thyroid gland in rabbits. It is generally recognized that the use of drinking water from certain wells and springs in goitrous districts is commonly followed by a development of the disease, while the use of a different water supply is free from such evil potency.

Whatever the harmful constituent may be, it is commonly rendered innocuous by boiling the water. Munson believes, from his extensive investigations among the Indian tribes of the United States, that the disease is not caused by high altitudes, climate, or water, but that "it is caused by unsanitary surroundings, depressing constitutional conditions, and an improper and excessively nitrogenous diet."

Pathological Anatomy.—The pathological changes observed in such enlargements of the thyroid gland as have been included under the name of goitre in the present article have led to their classification according to the structural elements which are chiefly involved.

The parenchymatous goitre is characterized by a hyperplasia of the glandular follicles, with epithelial changes and an increase in their colloid contents. In places the septa disappear and a group of follicles becomes converted into small irregularly shaped cavities filled with colloid matter. The parenchymatous goitre is usually soft in consistence and prone to the development of fatty, fibroid, and cystic changes of a secondary nature.

The fibroid goitre may arise either primarily or in association with parenchymatous changes by a hyperplasia and sclerosis of the interstitial tissue of the gland. As a rule, the process is not general, but the fibrous tissue is aggregated in firm, hard nodules of variable size scattered through the gland. Usually the vascularity is notably diminished. This form may also undergo cystic and other degenerations, beginning either in the follicular spaces or as a sequence of hemorrhagic extravasations, so that the ultimate structure may be very composite.

The vascular goitre is usually a soft, compressible tumor, characterized by the presence of dilated arteries and varicose and tortuous veins, with almost complete disappearance or degeneration of the other elements of the gland. If the arteries predominate, the tumor may be pulsatile. The vascular dilatation frequently extends to the communicating vessels of the neck.

The colloid goitre is an advanced stage of the colloid change in the follicles which is found in parenchymatous goitre. It may result in the formation of large cystic cavities filled with gelatinous contents and surrounded by expansions of sclerosed tissue.

Various secondary processes further modify the result of the commingling of the typical forms which have been described. Cystic changes have been alluded to in connection with fibroid and colloid goitres. Traumatism and infections, among other causes, may give rise to inflammation, with diffuse suppuration, or perhaps to abscess which

may evacuate externally; hemorrhage may occur into the cavity of a cyst or abscess; and, finally, calcareous or carcinomatous degenerations are a common sequel.

The various morbid processes noted may involve the whole gland or only a portion of it.

Symptoms.—Small goitres and also those of very large size may be unattended by any symptoms or signs beyond those of enlargement of the gland. On the other hand, even in goitres of small size, moderate palpitation and increased frequency of the heart's action may be present, although usually not in a persistent form. In goitres of large size pressure symptoms often exist. Pressure on the cervical veins gives rise to appreciable congestion of the face and neck, headache, sensations of fulness in the head, dizziness, flashes of light, fulness in the ears, and a feeling of faintness. Epileptiform convulsions occasionally occur through compression of the arteries. Laryngeal paralysis with its attendant dangers, also is occasionally caused by pressure on the recurrent nerve. Exceptionally, the trachea is sufficiently compressed to produce serious interference with respiration; the breathing becomes stridulous and asphyxia is threatened. If the goitre is situated low down (retrosternal goitre), the danger of tracheal compression is greatly increased and pressure upon the innominate veins is possible. Dysphagia through compression of the œsophagus is a very rare symptom.

Diagnosis.—The diagnosis of goitre is easily made. A tumor lying on the trachea and moving upward in the act of deglutition almost certainly is thyroidal and probably of a benign character.

The differentiation of the various forms of goitre is more difficult. For this purpose Weir[1] advises that the tumor be lifted forward with one hand while the head of the patient is bent forward. By this procedure it is often possible to "feel the smooth, elastic nodules of adenomata and cysts, the smooth surface of diffuse parenchymatous enlargement, or the irregularities of a fibrous goitre."

Prognosis.—The prognosis in acute goitre is favorable. In the chronic form an opinion must be based largely upon the presence or absence of severe pressure symptoms.

Treatment.—*Prophylactic and Hygienic Treatment.*—Removal from districts where goitre is endemic is to be recommended to individuals possessing an hereditary predisposition to the disease, and also in cases where the symptoms have already developed. A change of residence to districts free from goitre has been found efficient in arresting or curing the disease in its early stages. The drinking water, unless boiled, should be avoided in regions where goitre prevails in an endemic form.

Medicinal Treatment.—In cases of comparatively recent development the use of iodine and its compounds is often followed by excellent results. Either iodide of sodium or potassium may be employed in daily doses of ten to fifteen grains. Large doses often aggravate the symptoms. If iodine is used, five to ten minims of the tincture may be given twice or thrice daily.

Fresh thyroid glands and their extracts have been extensively used since 1893 in the treatment of goitre. Although cysts, fibrous tissue,

[1] *Dennis's System of Surgery*, p. 824.

and extensive collections of colloid material are apparently unaffected by their use, there is convincing evidence of the atrophy of hyperplastic and adenomatous tissues, with an accompanying improvement in the constitutional symptoms under their influence. In 60 cases treated by Bruns[1] by this method, 14 were cured, 29 were improved, and 17 were unimproved. At the beginning of treatment the equivalent of three or four grains of the fresh gland may be given daily, and the dosage gradually increased to fifteen or twenty grains. The treatment extends over a period of several weeks. The symptoms of over-dosage are similar to several which naturally occur in exophthalmic goitre—palpitation, increased frequency of the heart's action, sweating, and emaciation.

Phosphate of soda given alone or combined with the thyroid extracts is very highly spoken of by Kocher.[2] The glycero-phosphate of soda is an excellent form for use, and may be given in fifteen- to twenty-grain doses thrice daily.

Mikulicz[3] claims good results from the use of fresh thymus gland. The equivalent of sixty or seventy grains of the fresh gland in the form of the extract may be given daily.

Among external remedies, iodine or its compounds have been found to be the most valuable.

Cunningham[4] has used the ointment of the red iodide of mercury as a local application, and claims that thousands of goitrous patients treated by him by this method in India have been cured. The technique of its application will be described in the section on Exophthalmic Goitre.

Injections of iodine into the diseased gland have been extensively employed for reducing its volume, and frequently with excellent results. They should only be employed under the strictest aseptic precautions. Ten to fifteen minims of the tincture may be used for a single injection, which should be repeated at intervals of two or three days until ten or more injections have been given. The treatment, however, is not unattended with danger.

Weir[5] regards iodoform as the most valuable substitute for iodine. He recommends v. Mosetig's mixture of iodoform 1 part. ether 5 parts, and olive oil 9 parts, or Garre's, in which the proportions are 1 : 7 : 7. Judging from the experience of these authors, this treatment is free from danger.

In the failure to ameliorate the symptoms or cure the disease by the methods described a recourse to surgical operation may be advised. The several surgical measures which are most strongly advocated at the present time are partial thyroidectomy, ligation of the thyroid arteries, enucleation, and enucleative resection. For a description of their technique the reader is referred to works on surgery.

[1] *Beiträge z. klin. Chir.*, 1894, vol. xii.
[2] *Correspondenzbl. f. Schweizer Aerzte*, 1895, No. 1.
[3] *Centrbl. f. Chir*, 1896, p. 929.
[4] *Quain's Dict. of Med.*, "Goitre."
[5] *Loc. cit.*, supra.

EXOPHTHALMIC GOITRE.

Ἐξ, out; *ὀφθαλμος*, the eye.

Synonyms.—Graves' disease; Basedow's disease; Tachycardia strumosa; Glotzaugenkropf; Maladie de Graves; Morbo di Flajani.

Definition.—A disease characterized by enlargement of the thyroid gland, palpitation, and increased frequency of the heart's action, by proptosis, fine tremor, and general nervousness.

The theories of its pathogenesis are, respectively, that it is dependent upon increased and probably perverted function of the thyroid gland, and that it is dependent upon a primary disease of the nervous system.

History.—In 1835, Graves[1] of Dublin in a published clinical lecture described a peculiar neurosis allied to hysteria and characterized by palpitation without organic heart lesion, by a persistent swelling of the thyroid gland, and by exophthalmos.

Previous to this date, as early as 1800, attention had been called by Flajani to the association of thyroid tumor with cardiac and pressure symptoms. There had also been reported cases of exophthalmos unexplained by local symptoms, in some of which vascular or nervous symptoms were present. Of especial interest are the 13 cases described by Parry in the manuscripts published in 1825 (after his death), all of which seem to have been genuine examples of exophthalmic goitre.

The original paper of Graves apparently attracted little attention, and it was reprinted in his *System of Clinical Medicine*, published in 1843. In the mean time, von Basedow[2] in 1840 made 4 cases which he had observed the basis of a thorough discussion of the disease, and clearly grouped together the three most characteristic clinical phenomena —the goitre, the increased frequency of the heart's action, and the proptosis. His publication led his countryman Brueck to recognize the true nature of 3 cases reported by him (Brueck[3]) in 1835. In 1840, Marsh[4] of Dublin, unaware of the observations of Graves, gave an oral description of the disease before the Dublin Pathological Society, and in the following year supplemented it by a paper read before the same society, based upon 2 well-marked cases, 1 of which furnished the first recorded autopsy.

It is therefore seen that the conflicting claims which have been perpetuated in the nomenclature of the disease have been due to the independent and nearly simultaneous observations of several clinicians. Since 1840 the literature of exophthalmic goitre has progressively increased until at the present time it is very voluminous.

Etiology.—*Predisposing Causes.*—Hereditary predisposition appears to exercise a certain amount of influence in the production of the disease. Exophthalmic goitre repeatedly has been observed in several members of the same family, and the frequency of its occurrence in families in which a predisposition to neuroses in general exists is recognized. Not only a neurotic predisposition, but actual neuroses, hysteria, epilepsy, and psychoses, frequently have been noted in individuals who

[1] See interesting account of the history of the disease by W. Wickham Legg: *St. Bartholomew Reports*, 1882, p. 7.

[2] *Wochenschrift f. d. gesammte Heilkunde*, Berlin, 1840, 197 and 220.

[3] *Ibid.*, 441.

[4] *Dublin Med. Journ.*, xx., 1842, 471.

later have developed the disease. A sufficiently large number of cases have been reported to indicate that direct inheritance must be admitted in some instances. The remarkable family history reported by Oestreicher[1] is especially interesting on this point: Out of 10 children whose mother was hysterical, 8 suffered from exophthalmic goitre. The daughter of one of these had four children, one of which had exophthalmic goitre, another moderate goitre, a third bilateral exophthalmos, and the fourth became hysterical at the age of eleven. One of the 10 children referred to, who was herself normal, had a son who became epileptic.

Cheadle,[2] Hale White,[3] Wild,[4] and Joffroy,[5] among others, have reported similar although less notable instances of apparently direct inheritance. In Cheadle's group of cases two sisters, a cousin, and an aunt were affected. I have had the opportunity of seeing a grandmother, a mother, and a daughter in each of whom a goitre with tachycardia and marked general nervousness existed. It was stated that a goitre had also been present in the great-grandmother on the maternal side. The picture of exophthalmic goitre, save in the absence of appreciable proptosis, was very striking. The goitre in the daughter, a girl of sixteen (fourth generation), had only very recently developed.

The influence of sex is very evident. Women are affected much more frequently than men. In 980 cases collected by several writers and given by Buschan[6] the ratio is 4.6 females affected to 1 male. Of 33 cases of which I have kept records, coming under my personal observation, 3 have been in men and 30 in women. The middle period of life, between puberty and the climacteric, furnishes the largest number of cases. Only exceptionally is the disease developed after sixty. Its occurrence in childhood is comparatively frequent. A well-marked example in a child of two and a half years has been noted, and a number of cases between five and fourteen years have been reported. Typical cases in a boy of fourteen and a girl of the same age have been observed by me. The suggestion of the possible etiological significance of disturbances of the menstrual function has arisen from the much more frequent occurrence of the disease in women and during the period of functional activity of the generative organs, and, finally, from its not infrequent association with irregularities of menstruation and from the exacerbation of the symptoms at the menstrual period. Their importance is easily exaggerated, and their influence may properly be considered in the same light as the depressed nervous vitality consequent upon anæmia and exhausting processes in general.

In a very considerable proportion of cases no predisposing influence is appreciable.

Exciting Causes.—Various profound mental impressions, sudden fright, grief, or continual mental anxiety, often seem to be the immediately exciting cause of the outbreak of symptoms. A number of cases have been reported in which palpitation, tachycardia, and swelling of the thyroid gland have developed in a few hours or days under such

[1] *Wiener med. Presse*, 1884, p. 335.
[2] *St. George's Hosp. Rep.*, vol. vii. p. 81.
[3] *Brit. Med. Journ.*, 1886, ii. p. 151.
[4] *Lancet*, 1890, ii. 545.
[5] *Prog. méd.*, 1894, p. 206.
[6] *Die Basedow'sche Krankheit.*, Leipzig, 1894.

conditions. Trousseau[1] relates an instance where the three so-called cardinal symptoms appeared in a single night in a woman who had been greatly affected by the loss of her father. A very similar case has occurred under my observation: a woman was seized suddenly with violent palpitation and tremor, followed very speedily by enlargement of the thyroid and protrusion of the eyes, at the sight of her husband covered with blood from a wound received in a railway accident. The probable existence of the disease, however, antecedent to the development of prominent symptoms should be recognized. A case recently reported by Patterson[2] is suggestive in this respect. The operation of removal of the tonsils in a girl of fifteen was attended with a good deal of agitation, and slight tremor of the hands was noted. In the course of the next three weeks enlargement of the thyroid, exophthalmos, and, lastly, tachycardia developed. The tremor also extended to the legs. Inquiry elicited the fact that for eighteen months previous to the operation the patient had been troubled with tremor of the hands, which had occasionally made writing difficult, and latterly had been more marked. A similar case has been reported by Reymond,[3] in which acute symptoms suddenly appeared following great anxiety in a woman of forty-five years. Death occurred on the fourteenth day. There had been continuous tremor for more than a year preceding the acute outbreak. In the case of a very intelligent patient recently under my care it was stated by him that for several weeks before there was any evidence of palpitation a trembling of the hands had interfered seriously with his occupation, that of a bookkeeper. Tremor, general nervousness, and tachycardia were present when he first sought my advice. Enlargement of the thyroid occurred six weeks later. In the light of the subsequent histories of the cases and of the recognized diagnostic importance of this symptom the tremor was undoubtedly an expression of existing exophthalmic goitre.

Without any appreciable exciting cause the outbreak of pronounced symptoms not infrequently is sudden.

Moebius[4] makes the statement that typical symptoms of exophthalmic goitre occur in horses, dogs, and cows.

Symptoms.—Instances such as have been cited, among others, suggest a possible latency of the disease for a very considerable period. The outbreak of readily recognized symptoms may be sudden.

The course of the malady may be either acute or chronic. Three rapidly fatal cases are quoted by Osler,[5] one in which death occurred on the third day subsequent to the development of pronounced symptoms, although for some time previous a slight prominence of the eyes had been noted. Reymond's case, in which death occurred on the fourteenth day, has been related. In 4 cases of Mueller's[6] there was a fatal issue in three and a half, two, one, and three months respectively after the appearance of the first symptoms.

Circulatory System.—The symptom which usually first attracts the attention of the patient is palpitation. It is associated with an accelera-

[1] *Clinical Medicine.*
[2] *Lancet*, 1894, i. 1370.
[3] *Bull. de la Soc. Anat. de Paris*, Ser. 5, vol. vii. No. 18, p. 456.
[4] *Nothnagel's Sp. Path. and Ther.*, xxii. ii. p. 16.
[5] *Practice of Medicine*, Philadelphia, 1892.
[6] *Deutsche Archiv f. klin. Med.*, 1893, li. 395.

tion of the pulse, which at first may not be constant, but which later, as a rule, becomes continuous, although subject to great temporary variations in the presence or absence of emotional excitement. The rate varies from a moderate increase to frequently 140 beats. A pulse of 160 is not uncommon, and I have once observed a pulse of 200, the symptom occurring, however, only paroxysmally and lasting variously from twenty-four to forty-eight hours. Very exceptionably has an absence of this symptom been noted, and indeed by most observers some acceleration of the heart's action is considered an essential feature of the disease.

The acceleration, as a rule, is unaccompanied with irregularity of rhythm, except paroxysmally under emotional excitement, when in my experience it is not uncommon. The apex impulse is increased. As a rule, there is no enlargement. The sounds may be very intense. A soft systolic murmur is often present over the pulmonary area, and not infrequently at the apex. Other common circulatory phenomena consist in strong pulsation of the carotids and their larger branches, also of the retinal arteries. Occasionally pulsation may be detected in the aortic notch behind the sternum, also of the abdominal aorta. Guthrie[1] has reported a case where the pulsation of the abdominal aorta was so violent as to be visible under the bed-clothes; it ceased abruptly at the umbilicus. Exceptionally, pulsation is appreciable in the peripheral vessels.

Ocular Symptoms.—A bilateral exophthalmos, although one eye often is affected earlier than the other, and later not infrequently the phenomenon is more marked on one side than the other, is a second cardinal symptom of the disease. It varies greatly in degree, from a prominence of the eye scarcely appreciable to extreme protrusion, even dislocation. Exceptional cases have been reported in which the symptom was apparently absent; one instance at least of this kind has come under my observation. The onset of the exophthalmos is usually gradual: exceptionally the maximum degree in a given case has occurred within a few days. The protrusion is subject to transient fluctuations, not infrequently becoming more marked under the influence of mental excitement and during the menstrual period. Such fluctuations, are commonly associated with increased acceleration of the heart's action and palpitation. Two exceptional cases of crossed exophthalmos have been reported by Burney Yeo.[2] In one there was left exophthalmos and enlargement of the thyroid on the right side; on the left side the hairs of the eyebrow and the lashes had disappeared. Later, the thyroid on the left side became enlarged, and was followed by baldness of the eyebrow and loss of the eyelash of the opposite side. As a sequence of the exophthalmos and impaired protection of the eye disturbances of the nutrition of the bulb may occur. Usually the conjunctiva alone suffers, but in severe cases the cornea may become affected. Infiltrations appear on the surface at one or more points, followed by ulceration and even perforation. Pupillary changes are uncommon. Mueller,[3] however, observed in his cases a bilateral fluctuation in the diameter of the pupil during quiet fixation in direct gaze. The combination of the ex-

[1] *Brit. Med. Journ.*, 1893, ii. 893. [2] *Lancet*, 1893, vol. ii. p. 1003—discussion.
[3] *Deutsche Archiv f. klin Med.*, 1893, li. 335.

ophthalmos, the unusual exposure of the sclerotic, and the dryness of the eye give a peculiar staring and rather savage expression to patients suffering from this disease. A lack of harmony in the movements of the eyeball and the lids in exophthalmic goitre is a symptom first described by von Græfe,[1] and is known as "Græfe's sign." Normally, as the glance rises or falls the upper lid executes a corresponding movement. In exophthalmic goitre this movement is reduced to a minimum or is fully arrested. Various theories have been advanced in explanation. Von Græfe regarded the phenomenon as due to a disturbance of innervation of the smooth (organic) muscle of the lid, described by Heinrich Müller and known as "Müller's muscle." It receives its innervation from the sympathetic. Gowers[2] believes it to proceed from a spasm in Müller's fibres or of the levator palpebræ superioris. Although regarded by von Græfe as an early and characteristic symptom, it is frequently absent.

In addition to von Graefe's symptom, an abnormally wide palpebral fissure has long been noted, and, finally, a condition described by Stellwag,[3] and known as "Stellwag's sign," is very commonly present. This has been termed "defective winking," from the infrequency and incompleteness of the involuntary or automatic closure of the lids. Stellwag believes the phenomenon to be due neither to the exophthalmos, nor to an abnormal tension of the levator palpebræ superioris, nor to an abnormal activity of Müller's muscle, but to a diminished efficiency of the orbicularis. This in turn depends on an impairment of the reflex which proceeds from the sensitive nerves both of the exposed surface of the eyeball and of the retina when the lids are open, and whose function it is to maintain not only a certain degree of vital tension in the fibres of the orbicularis, but to determine their rhythmic contractions. Stellwag's sign may be present either with or without the existence of von Graefe's symptom.

Tremor of the eyeballs has been described, usually in a vertical direction (Mannheim,[4] Bruns,[5] Devlin, a personal case).

Enlargement of the Thyroid Gland.—Appreciable enlargement of the thyroid gland is present in the great majority of cases. In 29 of 283 cases collected by Murray[6] from different sources it is stated that no enlargement of the gland was observed. But, as Murray remarks, it is exceedingly difficult to determine a slight enlargement unless the patient is unusually thin, and it is probable that an increase in size at one time or another in the course of the disease is present in all cases. The usual form is that of a soft, rather elastic swelling, affecting one or both lateral lobes or the whole gland. Exceptionally, the isthmus alone is involved. Later the tumor tends to become more resistant and firmer in character. The right lobe is affected to a greater degree than the left in the experience of many observers and in my own. Very rarely is the enlargement confined to a single lobe throughout the course of the disease. Similar variations in size occur as in the exophthalmos and pulse acceleration, and apparently under similar conditions. The

[1] *Deutsche Klinik*, 1864, p. 158.
[2] *Diseases of the Nervous System*, 1st ed., vol. ii. p. 818.
[3] *Wiener med. Woch.*, 1869, p. 737.
[4] *Der Morbus Gravesii*, Berlin, 1894, p. 26.
[5] *Neurol. Centralb.*, 1892, p. 6.
[6] *Twentieth Cent. Prac. of Med.*, vol. iv. p. 772.

enlargement, as a rule, is only moderate, in contrast to that observed in simple goitre, although exceptionally cases have been observed where paroxysmally it has been sufficient to threaten suffocation. A notable instance of this kind has been described by Trousseau.[1]

A thrill frequently is palpable over the enlarged gland, and a loud systolic murmur or a bruit de diable. Guttmann[2] regards the arterial murmur as of much diagnostic value. He believes it to be due partly to irregular widening of the arteries of the thyroid, which has been described by other observers. The murmur is not present in simple goitre. Actual pulsation of the gland, though commonly accepted as a frequent phenomenon, I have never seen, though I have carefully examined for it—an experience which harmonizes with that of Greenfield,[3] lately expressed. Pulsation transmitted from the carotids is very common. The veins over the gland are not infrequently distinctly dilated.

A certain orderly sequence in the development of the so-called cardinal symptoms—viz. accleration of the pulse and palpitation, enlargement of the gland, and finally exophthalmos—is mentioned in many textbooks. A more careful study of cases and the early recognition of the disease indicate that such a sequence is more apparent than real. The error has arisen partly from the fact that palpitation, as a rule, is the symptom which first attracts the patient's attention and for which he seeks relief. Any one of these symptoms may precede the others, or all may develop apparently simultaneously.

Turning from the consideration of the triad of so-called cardinal symptoms, others of equal importance and later study attract our attention.

Nervous System.—*Tremor.*—Marie[4] has described very fully a fine tremor in exophthalmic goitre. It is a very constant symptom, although its intensity is very variable. Occasionally it so predominates that it is the chief symptom which attracts the patient's attention; more frequently it is appreciable only when the patient is placed under favorable conditions for observation. It may be general or confined to the extremities. In the case of the upper extremities it is most evident in the hands—"not," Marie says, "so much because they are the seat of the motion as because they are farther removed from the axis of motion, and also from the fact that at this point the muscular succussion becomes aggregated." The tremor in the lower extremities is best appreciated by seating the patient with the knees at right angles and the toes resting on the ground. The tremor may be sufficient to interfere with the finer movements of the hands and to impede walking. Marie's chronograph shows the vibrations to be of extreme rapidity and to occur with perfect rhythm. The rate of frequency was found to be very uniform—from eight to nine and a half oscillations per second, corresponding to that of alcoholism, and in contrast to that of senile tremor (four and a half to five and a half per second). Marie also noted that the amplitude of the excursions underwent a curious periodic variation, which was not perfectly regular as to interval, and which did not appear to bear any relation to respiration or circulation. In considering the

[1] *Loc. cit.*
[2] *Deut. med. Woch.*, 1893, 254.
[3] *Lancet*, 1893, ii. 1493.
[4] *Thèse de Paris*, 1883.

etiology of the disease reference was made to cases in which fine tremor apparently had been the first symptom. My personal experience is that this symptom frequently is of very early occurrence.

A much coarser tremor has been described by George Johnston[1] as occurring in typical cases of exophthalmic goitre. In the instances cited it involved the whole body, though more marked on the right side. "The contractions of the pectoral muscles were so violent as to jerk the shoulders forward, almost suggesting chorea." It would seem justifiable to regard such a degree of "tremor" as a mild grade of tetany.

Paralyses.—A great variety of paralyses of varying degree may be associated with exophthalmic goitre. While many of them may be regarded, tentatively, as accidental complications and others as hysterical in nature, there remain a certain number which would seem to be specifically associated with the pathology of the disease. (To this class I would assign largely the ocular pareses.) The paralyses embrace mono-, hemi-, and paraplegias. In the order of frequency Joffroy places ophthalmoplegia first; then paralysis of the facial muscles, the jaw, the tongue, and velum palati, in the order named. It is unquestionable that pareses both of the ocular muscles and of the oculo-facial group (frontalis, corrugator supercilii, and orbicularis) are comparatively frequent. In recorded cases there are instances both of unilateral and bilateral ophthalmoplegia externa, partial or complete. It is recognized that this phenomenon is occasionally of a functional nature, and, moreover, it should be borne in mind that in certain cases where it has been observed in exophthalmic goitre the patient exhibited hysterical symptoms. In a case of Joffroy's,[2] however, and in several other reported cases it would seem justifiable to exclude the hysterical character of the ophthalmoplegia. In a single case I have observed ophthalmoplegia interna without implication of the external ocular muscles. The case was a very typical one of the disease, occurring in a female twenty years of age. An enlarged thyroid, tachycardia (pulse 120), exophthalmos, tremor, and general nervousness were present. There was almost complete loss of pupillary reaction to light and for accommodation.[3] A slight paresis of the lower extremities is very common, and a sudden weakness and giving way of the lower extremities, simulating paraplegia, has been described by Charcot,[4] Homen,[5] and Mackenzie. It has been a conspicuous symptom in 7 personal cases of which I have notes. The symptom was described voluntarily by the patients. In walking, suddenly the knees gave out, and unless supported the patient fell. On careful examination no more than a slight motor paresis was appreciable. The symptom was observed in 12 cases by Mackenzie.[6]

Exceptionally, complete paraplegia has been observed. Maude[7] believes from his personal experience that three classes of such pareses and actual paralyses can be distinguished: 1, cases of astasia-abasia, not of true paresis: 2, cases of hysterical type; 3, cases due to interruption of motor impulses low down in the motor tract, either spinal or peripheral.

[1] *Lancet*, 1893, ii. p. 1121. [2] *Progrès méd.*, 1893, xviii. 477; 1894, xix. 61, 165.
[3] Joffroy states that internal ophthalmoplegia has not been observed.
[4] *Wiener med. Woch.*, 1889, p. 474. [5] *Neurol. Centrbl.*, 1892, p. 427.
[6] *Lancet*, 1890, ii. p. 545. [7] *Brain*, 1894, vol. xvii. p. 249.

Bryson[1] has described a diminished respiratory expansion of the chest, the difference in the chest circumference in inspiration and expiration amounting only to 2.5 c.c. He believes the sign to be due to a weakening of the respiratory muscles.

Muscular Atrophy.—Impairment of the nutrition of the paralyzed muscles rarely has been observed. In a very carefully recorded case by Huber[2] the reaction of degeneration was present in the affected arm.

Patellar Reflex.—The patellar reflex is not infrequently absent. Marie has found it usually diminished or absent—and Maude has made a similar observation—in nearly all severe cases of the disease. As tabes has been present coincidently in a certain number of reported cases of exophthalmic goitre, it is important to exclude its existence in the absence of the patellar reflex.

Cramps and Tetany.—Mackenzie[3] has called attention to the not infrequent occurrence of painful cramps. In some cases the hands only are attacked, but more frequently the feet and legs are affected. Their occurrence is more common at night while the patients are in bed. Joffroy[4] corroborates the observations of Mackenzie as to the frequency of spastic contractions of the hands and feet, and believes that they may be of thyroidal origin, similar to the tetany which may supervene after removal of the gland.

Vaso-motor Symptoms.—Sensations of heat and hot flushings are of common occurrence and may be of a very distressing nature. In addition to an unusual moisture of the skin which is commonly present, profuse sweating independent of physical exertion is a frequent symptom.

An occasional and interesting phenomenon is œdema. Exclusive of the œdema dependent upon accompanying cardiac disease, and a slight swelling about the instep and ankle which often is present, there is a form of œdema transitory and circumscribed in character which undoubtedly is dependent upon vaso-motor disturbance. Under this head should be included the swelling of the eyelids which has been observed exceptionally (Mackenzie,[5] Maude,[6] Booth[7]). I have observed it in a single instance.

An especially interesting case of angio-neurotic œdema has been reported by Hay.[8] In a woman presenting all the characteristic symptoms of exophthalmic goitre, during a period of two weeks circumscribed swellings suddenly and irregularly appeared on the feet, legs, thighs, and lower portion of the abdomen. The persistence of an individual swelling was rarely more than twenty-four hours. The swellings were entirely painless and were unaccompanied with any systemic disturbance.

The exceptional occurrence of symmetrical gangrene in exophthalmic goitre (Strümpell,[9] Fournier and Olivier,[10] Hay[11]) probably may be regarded as also dependent upon vaso-motor influences. In Strümpell's, Fournier and Olivier's cases careful examinations after death failed to reveal any appreciable lesion of the heart or vessels. In Hay's case the

[1] *N. Y. Med. Journ.*, 1889, Dec. 14.
[2] *Deut. med. Woch.*, 1888, 729.
[3] *Lancet*, 1890, vol. ii. p. 546.
[4] *Loc. cit.*
[5] *Lancet*, 1890, ii. 545.
[6] *Practitioner*, 1891, xlvii. 401.
[7] *N. Y. Med. Record*, 1896, July 11.
[8] *Medical Age*, Detroit, June 10, 1891, p. 351.
[9] Strümpell: *Lehrbuch der spec. Path. u. Ther.*, Zweit. Ausgab., 1885, Bd. 2.
[10] *L' Union méd.*, 1868, p. 90.
[11] *Medical Age*, Detroit, June 10, 1891, p. 331.

gangrene was first symmetrically developed in a line extending from the lumbar spine to the symphysis, and six weeks later patches of gangrene appeared below each external malleolus. Especially interesting is the fact that these lesions occurred in the patient who also suffered from angioneurotic œdema.

Cutaneous System.—A great variety of skin affections have been described in persons suffering from exophthalmic goitre. Many of them, properly, should be regarded as accidental complications. The more interesting and common cutaneous lesions are pigmentation, vitiligo or leucoderma, and urticaria. Pigmentation is of comparatively frequent occurrence. A very interesting group of 6 cases in which this symptom was a conspicuous one was published by Drummond in 1887.[1] The observation was made that there was a coincidence in the improvement of the general condition and of the pigmentation. In the 3 fatal cases the pigmentation was marked after death. In none was pigmentation of the oral mucous membrane observed, and in none were the minute, deeply colored patches on the arms, so commonly noted in Addison's disease, present. Mueller,[2] however, reports a case in which pigmentation of the mouth existed. The favorite situations seem to be about the eyes, the lids, face, neck, axillæ, areolæ of nipples, abdomen, particularly along the linea alba and the various flexures: wherever pigment exists naturally, there it is increased. The patches may be defined or they may fade imperceptibly into the normal skin, and the color varies from a dirty pale liver color to a dark brown. General bronzing, although noted, is probably very exceptional. It is difficult to determine the true value of this symptom in exophthalmic goitre, but the weight of opinion points to its dependence upon morbid nerve functions characteristic of this disease.

Vitiligo has been observed by Reynaud,[3] Marie, Dujardin-Beaumetz, Joffroy, Drummond, Lucy, and others. It affects especially the trunk and extremities. Urticaria is of common occurrence and is often a pronounced and troublesome symptom.

In connection with cutaneous changes the defective nutrition of the hair and nails should be mentioned. Dryness, brittleness, and thinning of the hair are very common, and have been present in a large proportion of my own cases. Barnes[4] describes a case of exophthalmic goitre associated with diabetes in which there was an almost entire loss of the hair of the scalp, and largely of the eyebrows, of the eyelashes, of the pubes, and of the body generally. Reference has been made to Burney Yeo's interesting case. The nails may be thin and brittle, and they occasionally present a corrugated appearance.

The electrical resistance offered by the skin is notably diminished, as pointed out by Vigoroux,[5] but this phenomenon is not peculiar to exophthalmic goitre, and it varies widely according to the amount of manifest perspiration, to the abundance of which it is doubtless due.

Digestive System.—Gastro-intestinal disturbances are of frequent occurrence. Diarrhœa is the more usual form, although attacks of vomiting are not uncommon. In many instances these symptoms may justly

[1] *Brit. Med. Journ.*, 1887, vol. i. p. 1027. [2] *Loc. cit.*
[3] *Rev. gén. de Méd.*, 1875, i. 679. [4] *Brit. Med. Journ.*, 1889, vol. i. p. 1225.
[5] *Prog. méd.*, 1887, vi. 316.

be ascribed to nervous influences, although cases have been reported where extensive catarrh of the intestines existed; and Hale White[1] has called attention to the frequent enlargement of the intestinal lymphatic structures in exophthalmic goitre. The appetite in some cases is variably voracious, yet associated often with continuous emaciation. In cases of a severe type rapid and marked emaciation is the rule, although the appetite may be unimpaired.

Respiratory System.—Increased frequency of respiration is of common occurrence. Aside from those cases in which it is due to pressure effects, a nervous origin properly may be ascribed to it. A similar explanation may be given of the short dry cough not infrequently present. Finally, weak phonation and a nasal voice should be mentioned as occasional symptoms.

Fever.—The observations of different clinicians vary in regard to the presence or absence of pyrexia. My own experience in hospital suggests the probability that daily observations of temperature over considerable periods of time would show the presence of very moderate fever of a transitory character and irregular type in many cases, and especially in the graver forms of the disease.

Urine.—The occurrence of a variable polyuria independent of renal disease is not uncommon, and glycosuria has been noted by many observers, and especially in cases where the mental symptoms have been conspicuous.

Mental Symptoms.—Symptoms of mental disturbance of varying degree are almost invariably present. Joffroy believes that the psychoses present no definite type. They commonly consist in a distinct irritability and excitability of temper, less frequently in alternations of marked excitement and depression (melancholia), though true alternating mania has not been observed, according to Joffroy. Insomnia is a common symptom. Occasionally a slight perversion of the moral nature has been noted. Even where pronounced symptoms of mental disturbance have been absent previously, their frequency in fatal cases toward the end is noteworthy. The usual form in such cases is great excitement, delirium, or even mania. Savage[2] reports 3 cases of exophthalmic goitre in which depression was followed by violent mania of the destructive and incoherent type. He also makes the interesting statement that he has seen several cases of acute mental disorder, associated with exophthalmic goitre, which have completely recovered with the disappearance of the bodily symptoms peculiar to the disease.

Kronthal[3] reports a case of marked mental disturbance in a child of twelve years whose mother was also a sufferer from exophthalmic goitre.

The association of at least one of the symptoms of exophthalmic goitre (thyroid enlargement) with mental disorder is well illustrated in a case reported by J. Hilton Thompson.[4] In a youth of nineteen (father neurotic and criminal, mother neurotic) recurring attacks of maniacal excitement, attended on each occasion with suspicious enlargement of the thyroid, were observed. The attacks were of a few days' duration, and disappeared coincidently with the swelling of the gland.

[1] *Brit. Med. Journ.*, 1886, vol. ii. p. 151.
[2] *Guy's Hospital Rep.*, 1882; also work on *Insanity*, 1884.
[3] *Berl. klin. Woch.*, 1893, 650.
[4] *Lancet*, 1895, vol. i. p. 1248.

Diagnosis.—Little difficulty is experienced in recognizing well-marked cases of exophthalmic goitre. The increased frequency of the heart's action, the enlargement of the thyroid, the proptosis, at once stamp the nature of the disease. The ill-defined forms, however, often escape recognition. A persistent tachycardia in the absence of cardiac disease should excite suspicion, as not infrequently this symptom precedes any obvious enlargement of the thyroid gland by an indefinite period. In other forms of tachycardia of a functional nature the increased pulse rate is rarely continuous over long periods of time. When this symptom is associated with the peculiar form of fine tremor which has been described, the true nature of the disease is even more strongly suggested. Fine tremor may be the first indication of exophthalmic goitre preceding all other symptoms by several months. Proptosis in the absence of tumor, hemorrhage, or aneurysm strongly suggests the existence of the disease, and when associated with v. Graefe's or Stellwag's signs permits of a positive diagnosis of exophthalmic goitre, in Moebius's[1] opinion. It is probable that a certain proportion of cases of exophthalmic goitre recover without the development of the more characteristic symptoms. Not infrequently cases have come under my observation in which tachycardia, a slight swelling of the thyroid gland, and general nervousness have existed, and have disappeared after varying intervals without at any time exhibiting other symptoms.

From simple goitre exophthalmic goitre may be differentiated by the character of the thyroid tumor, by the absence of proptosis, of fine tremor, and of the general nervousness which is so constantly present in the latter disease. In simple goitre it is not uncommon to find palpitation and an increased pulse rate, but these symptoms are not as persistently present as in the form under discussion.

Pathological Anatomy.—*The Thyroid Gland.*—A careful study of the structure of the thyroid gland in exophthalmic goitre is of comparatively recent date. Published reports of such studies indicate that structural changes varying in degree and kind are invariably present (Greenfield, Stewart and Gibson, Mueller, Joffroy and Achard, Vandervelde and Le Bœuf, Mikulicz). The changes found by Greenfield,[2] by Stewart and Gibson,[3] and by Mueller[4] were practically similar.

In Greenfield's cases there was an absence of any special vascularity except in the large superficial veins. The changes, although general, were not equally distributed or at an equally advanced stage everywhere, and consisted, in the early stage, in an alteration of the epithelium lining the spaces from a cubical to a columnar type. There was accompanying greatly increased proliferation of tubules and epithelium; little colloid material was present, which seemed to be replaced by a more mucinoid fluid. The newly formed tubules were lined with a single layer of cubical epithelium, and in their structure and in the regular arrangement of their epithelium corresponded to the tubules of a secreting gland. Greenfield further states that as a sequel of these proliferative changes a catarrhal condition is often found, and in cases of long duration an interstitial overgrowth is developed which gradually invades the glandular structure. Greenfield summarizes the changes as

[1] *Nothnagel's spec. Path. u. Ther.*, xxii. ii. 67.
[2] *Brit. Med. Journ.*, 1893, ii. 1261.
[3] *Ibid.*, 676.
[4] *Deut. Archiv f. klin. Med.*, 1893, li.

representing a true hyperplasia and indicating an exaggerated and probably perverted function.

Both Stewart and Mueller also mention the surprisingly small amount of colloid matter present in the acini.

From a careful study of the 5 cases reported by Joffroy and Achard [1] it would seem that in 2 the differences in thyroid lesions found from those described by Greenfield, Stewart, and Mueller is more apparent than real. In a third a similarity to adenomatous tissue is noted as present in portions of the gland. In a fourth case there was evidence of more or less cystic degeneration; and, finally, in the fifth case the gland was replaced by a dense mass of fibrous tissue retaining the form of the gland, with a few heaps of epithelial cells representing the original vesicles. In this case typical myxœdema had supervened on the subsidence of an equally typical exophthalmic goitre.

Of the 4 cases reported by Vandervelde and Le Bœuf [2] (3 personal and 1 of Reymond's), 1 was a polycystic goitre, the second probably a fibro-cystic goitre; the third case is considered by them to be of doubtful nature, but probably an example of an atypical hyperplasia of the thyroid gland. The lesions found in the fourth case were evidently produced by ligature of the arteries, and consisted of a fatty degeneration of the interstitial connective tissue and the phenomena of necrosis in the epithelial cells of the acini. In the 10 cases of Mikulicz, 7 are described as diffuse hyperplasias, 2 as cystic, and 1 as a hypervascular goitre.

It is evident, therefore, that, although anatomically an apparent true hyperplasia of the thyroid gland exists in many cases of exophthalmic goitre, lesions of simple goitre alone are found in others exhibiting an exactly similar symptom complex.

Finally, careful examinations have shown that a hyperplasia occasionally is present in glands which have not been appreciably enlarged during life.

Thymus Gland.—The thymus gland is occasionally persistent (Moebius,[3] Mackenzie, and Edmunds [4]). In Mackenzie's [5] case the thymus was spread out over the pericardium, forming a layer about a quarter of an inch thick, and a histological examination showed normal thymus structure.

Heart.—As a rule, there is an absence of lesions. Occasionally a moderate hypertrophy is present, with or without ventricular dilatation and endocardial disease.

Lymphatic System.—Hale White [6] has found enlargement of the lymphatic structures of the intestine, and Müeller [7] enlargement of the lymph glands of the neck.

Orbit.—The orbital fat is increased in amount (Johnstone,[8] Mendel [9]).

Nervous System.—The pathological anatomy of exophthalmic goitre presents no lesions of the nervous system which are either constant or characteristic.

[1] *Arch. de Méd. exp. et d'anat. Path.*, 1894, Jan. 10.
[2] *Trans. de Méd. Clin. et Pharm.*, Brux., 1894, Mar. 3.
[3] *Deut. Zeitsch. f. Nervenheilk.*, 1891, Bd. i. 400.
[4] *Brit. Med. Journ.*, 1896, ii. 895.
[5] Mackenzie: *American Journ. of Med. Sciences*, Feb., 1897, p. 149.
[6] *Brit. Med. Journ.*, 1886, ii. 151.
[7] *Deut. Arch. klin. Med.*, li. 335.
[8] *Journ. Mental Sciences*, 1884, xxix. 521.
[9] *Deut. med. Woch.*, 1892, 89.

Lesions of the sympathetic nerve and ganglia have been reported in a certain number of cases. These changes, according to Peter,[1] have consisted in hyperæmia, swelling of the ganglia, particularly the inferior cervical, increase of connective tissue, and diminution in number and volume of nerve fibres. Goldscheider[2] reports a slight difference between the two sides in the reactions to staining fluids: Greenfield[3] found the ganglia swollen, marked hyperæmia, invasion of leucocytes, and degenerative changes in the ganglion cells in 2 cases—a condition which he sums up as a subacute inflammatory process. Mueller[4] found the macroscopic appearances normal in 2 cases; the nerve thinned, but otherwise normal, in 1 case; and normal, except where it had been involved in the changes produced by a spinal abscess, in a fourth case. Microscopically, in 3 of these cases he found a small proportion of shrunken and pigmented cells in the upper and lower cervical ganglia—a condition which he does not regard as important, since it was found to the same degree in control preparations made from subjects of equal ages. He also examined the cardiac nerves in 2 cases, finding 1 normal, and in the other a diminution in the number and a decided degree of degeneration of the medullated fibres, while the non-medullated were unchanged. Knight[5] reports variations in measurement of the cervical ganglia on opposite sides of the neck, with an increase in the connective-tissue stroma on the side corresponding to the enlarged thyroid lobe. In this case there was no exophthalmos.

With reference to the above-mentioned changes W. Hale White[6] has shown, by a careful series of investigations on patients dying from other diseases, that marked variations occur in the size of the cervical ganglia, that variations in vascularity as observed by the naked eye have no significance, that the cellular elements are found in various degrees of number and integrity, and that the fibrous stroma is so variable as to prevent any definite statement. Mendel[7] also calls attention to the fact that the presence of atrophy of nerve cells in the cervical ganglia of the adult has no special significance.

Wilks[8] reports a case in which the gross appearances were modified by adherent dense fibrous tissue, but the minute examination failed to show any decisive departure from the normal. In a case reported by S. Smith[9] there was entire destruction of the left inferior cervical ganglion, but the sympathetic was otherwise normal. W. Hale White[10] examined a case in which the cervical sympathetic and the cells of the ganglia were normal, though the sections through the latter were crowded with leucocytes.

The negative findings are much more numerous. Fournier and Ollivier[11] report a case marked by absolute integrity of the great sympathetic in the neck, thorax, and abdomen. Other cases have been noted by Roosevelt[12] and by Hammar.[13] The latter states that he has

[1] *Gaz. heb.*, 1864, p. 180.
[2] *Berl. klin. Woch.*, 1892, p. 467.
[3] *Brit. Med. Journ.*, 1893, ii. 1261.
[4] *Deut. Archiv f. klin. Med.*, 1893, vol. li.
[5] *Boston Med. and Surg. Journ.*, 1868, vol. i. p. 161.
[6] *Med.-Chir. Trans.*, 1885, Series 2, vol. 68, p. 221.
[7] *Deut. med. Woch.*, Feb. 4, 1892.
[8] *Guy's Hosp. Rep.*, 1870, vol. 17, p. 17.
[9] *Med. Times and Gaz.*, 1878, vol. i. p. 647.
[10] *Brit. Med. Journ.*, 1889, vol. i. 699.
[11] *L'Union mêd.*, 1868, Ser. 3, vol. v. p. 90.
[12] *Med. News*, 1888, Mar. 31, p. 353.
[13] *Upsala Lakeref Forhandling*, vol. 24, p. 200.

collected 22 cases of such examinations recorded in the literature of the subject from 1860 to 1887, and found that 15 gave the same negative result as in his own case. Ballet[1] alludes to the negative results of Ranvier and Déjerine, and calls attention to the absence of definite, incontrovertible lesions of the sympathetic reported in recent times and under modern technique. Still more recently the observations of Marie and Marinesco,[2] Mendel,[3] and the 5 cases of Joffroy and Achard[4] support this conclusion, the only positive findings of recent date being those of Greenfield, above quoted.

Apart from the region of the medulla and pons, the cerebro-spinal system has not been found to present any very significant changes.

Eger[5] reports adhesions of the dura mater over the convexity, and numerous pale red intermeningeal hemorrhages, more marked over the upper and posterior aspect of the cerebellum, the brain substance being moist and diminished in consistency, the lateral ventricles enlarged, but containing no excess of fluid. The meningeal hemorrhages did not encroach upon the cortex and there were absolutely no focal lesions.

Hyperæmic softening of the convolutions is also reported in a single case by Johnstone[6] and by Mueller.[7]

Joffroy and Achard[8] report adhesions over the posterior portion of the right hemisphere, which was the seat of a general congestion. The tip of the occipital lobe and the entire under surface presented the appearance of a venous angioma formed by large sinuses in the pia mater. These veins compressed the cerebral tissue, and in places invaded it so as to isolate little islands of nerve tissue. The other hemisphere was merely congested. The same authors[9] record a small focus of capillary hemorrhage in a perivascular sheath of the first frontal convolution, in a case which in other respects was absolutely negative.

Peter[10] reports a large hemorrhagic focus in the pons and medulla, death having been preceded by apoplectic symptoms of twenty-four hours' duration.

To these apparently irrelevant findings may be added the case of Vandervelde and Le Bœuf,[11] in which a very vascular neuro-sarcoma was discovered beneath the gray matter of the left superior parietal convolution.

In most of the reported autopsies no record is made of the condition of the brain and its membranes, so that the negative evidence is left to be inferred. The condition of the meninges is, however, stated to have been normal in cases examined by Cheadle,[12] Roosevelt,[13] Bristowe,[14] and by Mueller[15] in 2 of his cases.

From various theoretical considerations the condition of the medulla and pons, especially those regions in close relation to the nuclei of the pneumogastric, have been subjected to careful examination in most of the recent autopsies, but on the whole with very meagre results.

[1] *Rev. de Méd.*, 1888, pp. 337 and 373.
[2] *Rev. neurologique*, 1893, p. 250.
[3] *Deut. med. Woch.*, Feb. 4, 1892.
[4] *Arch. de Méd. exp. et. d'anat. Path.*, Jan. 10, 1894.
[5] *Deut. med. Woch.*, 1880, 153.
[6] *Journ. Ment. Sci.*, 1884, vol. 29, p. 521.
[7] *Deut. Archiv f. klin. Med.*, 1893, vol. li.
[8] *Arch. de Méd. exp. et d'anat. Path.*, 1891, p. 90.
[9] *Ibid.*, Jan. 10, 1894.
[10] *Gaz. heb.*, 1864, p. 180.
[11] *Journ. de Méd.-Chir.-Pharm.*, Mar. 3, 1894.
[12] *St. George's Hosp. Rep.*, 1879, vol. ix. p. 797.
[13] *Med. News*, 1888, Mar. 31, p. 353.
[14] *Lancet*, 1886, vol. i. 867.
[15] *Deut. Archiv f. klin. Med.*, 1893, vol. li.

Mendel[1] has reported an apparent atrophy of the restiform body in the left half of the medulla, with an atrophy of the solitary bundle on the opposite side. But in the discussion which followed the presentation of this case Oppenheim[2] instanced 2 cases of tabes dorsalis showing the same changes, in neither of which were there any symptoms of exophthalmic goitre, and stated that the symmetry of the solitary bundle was subject to physiological variations.

At a later date Joffroy,[3] reported a slight atrophy of the solitary bundle, but in this case also there were associated lesions of spinal sclerosis. Marie and Marinesco[4] have also reported a case of bilateral atrophy of the solitary bundle and the ascending root of the trigeminus in a case associated with tabes, but they found no signs of degeneration in the nuclei of the fifth, vagus, or glosso-pharyngeal. That such lesions are quite exceptional is shown by the fact that in 16 cases reported by recent observers (Joffroy,[5] Siemerling,[6] Koeppen,[7] Goldscheider,[8] Mueller,[9] Vandervelde and Le Bœuf, Joffroy and Achard[10]) the restiform bodies are described as absolutely normal.

Mueller, Vandervelde and Le Bœuf,[11] Greenfield,[12] and W. Hale White[13] have each noted recent capillary hemorrhages in the floor of the fourth ventricle, but only the two latter have considered that they had any significance. In White's case these minute foci were widely distributed superficially over the posterior surface of the medulla, especially in the neighborhood of the nuclei of the sixth nerve. These hemorrhages, although they did not occur immediately before death, were quite recent, and were believed to be significant of a slight degree of impairment of the tissues of a character too delicate to be noted by present methods of histological examination. Greenfield[14] describes a subacute inflammation of the pons and medulla characterized by vascular changes including minute hemorrhages and invasion of leucocytes into districts closely adjacent to the ganglionic centres. In many groups of ganglionic cells a few were to be found undergoing a process of atrophy of a kind allied to cloudy swelling, and the nerve fibres in some cases showed patches of leucocytes in their course outside of the brain. Similar changes were found in the sympathetic in both of his cases. The resemblance of these changes to the more advanced lesions of the same character noted in tetanus and hydrophobia leads Greenfield to believe that they are the result of a toxæmia.

Aside from accidental complications with other diseases, such as tabes and syringomyelia, the spinal cord has presented no lesions other than slight degrees of congestion, which has been noted in a few instances.

The vagus in one of Mueller's cases showed distinct changes: cross sections gave an intimate mixture of degenerated and normal fibres, the same condition being present, but to a less marked degree, in the recurrent. In several other reports the presence of a very few degenerate

[1] *Deut. med. Woch.*, Feb. 4, 1892.
[2] *Berl. klin. Woch.*, 1892, p. 467.
[3] *Prog. méd.*, 1894, p. 167.
[4] *Rev. neurologique*, 1893, 250.
[5] *Prog. méd.*, 1894, p. 167.
[6] *Berl. klin. Woch.*, 1892, p. 467.
[7] *Ibid.*
[8] *Ibid.*
[9] *Deut. Archiv. f. klin. Med.*, 1893, vol. li.
[10] *Arch. de Méd. exp. et dermat. Path.*, Jan. 10, 1894.
[11] *Journ. de Méd.-Chir. Phar.*, Mar. 3, 1894.
[12] *Brit. Med. Journ.*, 1893, ii. 1261.
[13] *Ibid.*, 1889, vol. i. p. 699.
[14] *Ibid.*, 1893, ii, 1261.

fibres is noted, but, as a rule, the pneumogastric and recurrent nerves have been found to be normal.

The peripheral nerves have not been systematically investigated, but a condition of neuritis has been recorded by Maude[1] and also by Joffroy and Achard.[2]

Pathology.—With a fuller knowledge of the clinical history of exophthalmic goitre the older theories of its pathology have been found to be untenable. At the present time two theories chiefly engage the attention of clinicians and pathologists, and are known as the nervous and thyroid theories respectively.

According to the former, the disease is primarily due to disturbance of the nervous system, either of a functional character or dependent upon structural changes.

According to the thyroid theory the fullest explanation of the symptom complex of the disease is found in a general toxæmia of the nervous system, the result of primary disease of the thyroid gland, leading to quantitative and qualitative changes in its secretion.

The Nervous Theory.—The absence of constant appreciable pathological changes in one or several portions of the nervous system—in the sympathetic, in the medulla, in the pons, in the spinal cord, and in the higher cerebral centres—has been fully shown in the consideration of the morbid anatomy of the disease. Disturbance of the function of the sympathetic, with or without appreciable structural change, while affording a probable explanation of several symptoms of the disease, fails to explain many. A fuller explanation is to be found in functional or organic disease of the medulla. Filehne in experimental investigations on rabbits found that by dividing the restiform bodies at various levels he was able to produce tachycardia and exophthalmos, and occasionally the autopsies showed swelling of the thyroid gland. Bienfait[3] later sought to verify Filehne's experiments, and was able to produce exophthalmos in 37 per cent. of his cases, due, he states, to "paralysis of the muscular tunic of the retrobulbar vessels." In some cases the phenomena of nervous excitation, tremor, convulsions, clonic and tonic, were also produced. The head, eyes, and thyroid body also showed distinct hyperæmia in certain cases. The same lesion, he found, however, was capable of causing either tachycardia or diminution in the pulse rate.

Many of the vaso-motor symptoms undoubtedly have their origin in the medulla, for here lie vaso-motor centres of undoubted importance. The dyspnœa, not dependent upon pressure effects or cardiac disease, and also the glycosuria and polyuria sometimes present, may have a similar origin. The ocular paralyses which are especially common, and which in many instances resemble nuclear paralyses, also suggests lesions of the medulla. The mental symptoms which frequently are so conspicuously present in exophthalmic goitre necessitate, however, the supposition of a disturbance of function of the higher cerebral centres, and, still further, the origin of the partial paraplegias must be sought for in functional or organic disease of the spinal cord. And similarly, the muscular atrophies occasionally noted and the diminished or

[1] *Brain*, Lond., 1894. [2] *Arch. de Méd. exp. et d'anat. Path.*, Jan. 10, 1894.
[3] *Bull. del' Acad. roy. de Belg.*, 1890, p. 470.

absent patellar reflex must have their source in cord disturbances or in a peripheral neuritis.

The complete symptom complex of exophthalmic goitre, it is thus seen, necessitates a very general involvement of the nervous system, and in the absence in recorded autopsies of resultant appreciable lesions affecting at once its various portions the theory that the pathogenesis of the disease is probably to be found in a general toxæmia of the nervous system, producing functional disturbances and sometimes leading to structural changes, possibly at the points of least resistance, seems very tenable.

The Thyroid Theory.—The evidence in favor of the thyroid theory may be summarized as follows:

1. The nature of the pathological changes present in the thyroid gland in many cases of exophthalmic goitre.
2. The antithesis of symptoms present in myxœdema and in exophthalmic goitre.
3. The speedy or gradual development of myxœdema subsequent to apparent recovery from exophthalmic goitre.
4. The effects produced by the administration of thyroid extracts in myxœdema, in health, and in exophthalmic goitre.
5. The efficacy of medicinal and surgical measures "which tend to diminish the volume or lessen the functional activity of the thyroid gland," in ameliorating or arresting the symptoms of exophthalmic goitre.

The nature of the pathological changes in the thyroid gland has been indicated in considering the morbid anatomy of the disease. In the vast majority of cases an apparently true hyperplasia exists, indicating an exaggerated and probably perverted function.

The antithesis of clinical phenomena in exophthalmic goitre and myxœdema is so striking and well recognized as to demand but brief consideration. The largest number of cases of exophthalmic goitre occur between the ages of twenty and thirty, during the period of the greatest activity of the generative functions. The interval between forty and forty-five, the period of beginning decline of these functions, furnishes the most numerous instances of myxœdema.

In exopthalmic goitre enlargement of the thyroid gland is present; in myxœdema, an atrophy of the gland. In the one case the skin is fine, soft, moist, and warm; in the other, coarse, hard, dry, with a tendency to desquamate, and cold; in the one, perspirations, often profuse in character and easily excited, are conspicuously present; in the other, their absence, even in the warmest weather, is equally noticeable. In exophthalmic goitre the temperature is never subnormal, and pyrexia of greater or less degree occurs on slight causes; in myxœdema the reverse holds good. In the former an excitable, mobile pulse, tachycardia, and palpitation prevail; in the latter a sluggish heart action and slow pulse. In exophthalmic goitre irritability and excitability; in myxœdema apathy and dulness of apprehension and perception attract the attention. In the former tremor is one of the cardinal symptoms; in the latter it is absent, except in its rare occurrence in the form of tetany. In exophthalmic goitre the nutrition of the hair, nails, and skin is, as a rule, well maintained; in myxœdema the reverse obtains.

The enumeration of contrasts in the clinical phenomena of the two diseases might be extended almost indefinitely, and the antithesis justly may be regarded as a not unimportant link in the chain of evidence in support of the thyroidal theory.

The speedy or gradual development of myxœdema subsequent to recovery from typical exophthalmic goitre is a strong argument in favor of the thyroidal theory.

In view of the nature of the pathological changes found in the gland in many cases of exophthalmic goitre—viz. an increase in the interstitial tissue in connection with alterations in the parenchyma, and which Greenfield states is a late process—this sequence is explainable on anatomical grounds.

Clinically, a very considerable number of cases have been recorded in which myxœdema has developed at varying intervals after the subsidence of the symptoms of exophthalmic goitre (Bowles,[1] Gowers,[2] Ord,[3] Corkhill,[4] Baldwin,[5] Joffroy [6]).

The effects produced by the administration of thyroid extract in health and in myxœdema are now well recognized. The susceptibility to its action in individuals in health undoubtedly varies somewhat, but doses rather larger than those found useful in myxœdema frequently increase the pulse rate from forty to fifty beats. The accelerated heart action is accompanied with palpitation, flushing, a feeling of fulness in the head, slight tremors, with profuse perspirations.

An especial susceptibility of patients suffering from myxœdema to the action of thyroid extract certainly exists. Large doses almost invariably produce pulse acceleration and palpitation, the temperature rises above normal, the skin becomes flushed and moist. If the dosage is pushed, there follow insomnia, restlessness, polyuria, diarrhœa, often fine tremor. Beclere[7] observed in a myxœdematous woman, who took by mistake at the beginning of treatment ninety-two grammes in eleven days, tachycardia, irregularity of pulse, elevation of temperature, insomnia, polyuria, glycosuria, albuminuria, incomplete paraplegia with heat sensations, perspirations, transient tremor of the arms, and slight exophthalmos.

It is needless to call attention to the similarity of these symptoms to those presented by the patient suffering from exophthalmic goitre: they embrace almost the complete symptom complex of the disease. They are such as would be anticipated if the symptoms of exophthalmic goitre are dependent upon an exaggerated function of the thyroid gland.

The efficacy of medicinal and surgical measures which tend to diminish the volume or lessen the functional activity of the thyroid gland, in ameliorating or arresting the symptoms of exophthalmic goitre, is at present recognized.

The good results obtained from the use of belladonna are probably due to its power of inhibiting to a greater or less degree the functions of secreting glands. Murray has found that the inunction of the red iodide-of-mercury ointment over the enlarged thyroid reduces its size,

[1] *Lancet*, 1893, ii. 1003.
[2] *Diseases of the Nervous System*, vol. ii.
[3] *Lancet*, 1893, Oct. 31.
[4] *Brit. Med. Journ.*, 1893, Jan. 7.
[5] *Lancet*, 1895, i. 145.
[6] *Prog. méd.*, 1894, 19, 168.
[7] *Soc. méd. des Hôpitaux*, Oct. 12, 1894.

and coincidently causes a distinct diminution in the symptoms of the disease.

Partial extirpation of the thyroid gland by one or another of several surgical methods, and necessarily attended with a marked diminution in the volume of its secretory structures, has been followed by a subsidence of many, if not all, of the symptoms of exophthalmic goitre, and in a large number of cases by complete recovery.

I have been able to collect 187 cases surgically treated. A summary of the cases shows that 13 died as the more or less immediate result of the operation, 60 are reported as having recovered, 47 improved, 11 unimproved; in 25 the result is unknown. In addition, 31 cases operated on by Kocher have resulted in various degrees of improvement, amounting in some cases to complete recovery.

It is thus seen that the effects of medicinal and surgical measures in relieving the symptoms of exophthalmic goitre, apparently through reducing the volume of the gland, strongly support the thyroidal theory.

Finally, in further evidence of the thyroidal origin of the disease may be mentioned the well-known aggravation and diminution in nearly all the symptoms simultaneously with an increase and decrease in the volume of the gland, which occur frequently in the clinical history of exophthalmic goitre.

In conclusion, it would seem that a preponderance of both pathological and clinical evidence is in favor of the view that the symptom complex of exophthalmic goitre finds its most satisfactory explanation in a general toxæmia of the nervous system, the result of quantitative or qualitative changes, or both, in the secretion of the thyroid gland; that for the complete expression of the symptom complex of the disease the existence of a neurotic predisposition is probably necessary; that the *ultimate* cause of the disease of the thyroid gland is still a matter of speculation.

Duration.—The duration of the disease varies within very wide limits, from a few months to many years. In a typical case in a boy of fourteen under my observation a complete recovery occurred in three months. On the other hand, Mackenzie recently has reported a case in a male in whom the symptoms of the disease when the patient came under observation had existed for seventeen years. A patient, female, was recently under my observation in whom all the characteristic symptoms had developed in an acute form twenty years previously. At the time of seeking advice exophthalmos, tachycardia, and general nervousness existed, but the goitre, which had been present for many years, was not appreciable by inspection or palpation. At times during the long course of the illness the disease had assumed an extremely grave character, and again for periods of considerable duration had been comparatively quiescent. There was an absence of valvular disease, but the patient has since died with symptoms indicating myocardial disease.

The literature of exophthalmic goitre shows that a duration of from two to six years is of much more common occurrence.

It should be borne in mind that a varying degree of exophthalmos may persist for years or indefinitely after the subsidence of all other symptoms. In the absence of increased frequency of the heart's action,

general nervousness, and enlargement of the thyroid, it is probably justifiable to claim recovery. My own experience is to the effect that in cases of apparently complete recovery, especially if the patient possess the neuropathic predisposition, a recurrence is to be feared under conditions known to be favorable to the development of the disease. A number of cases of simple goitre have been reported where the first symptoms of exophthalmic goitre have only developed many years after the occurrence of evident lesion of the thyroid gland, and in the present state of our knowledge it would seem proper to exclude such instances in estimating the duration of the disease.

PROGNOSIS.—The prognosis in exophthalmic goitre is favorable as regards life, although exceptionally cases run a rapid course of three or four months with a fatal issue. Even in such cases it is probable that the disease had existed in an ill-defined form before the development of the more characteristic and acute symptoms. In 900 cases collected by Buschan the mortality was 11.6 per cent. The immediate cause of death commonly is cardiac failure, which often is of sudden occurrence. The prognosis of complete recovery is more favorable in children than in adults, and is apparently more favorable in women than in men. An increase in body weight and a decrease in pulse rate are of favorable significance. The occurrence of pregnancy exercises a distinct effect, often arresting or even curing the disease.[1] When the disease has existed for more than six years the prognosis of complete recovery is unfavorable.

Broadly speaking, the rapid development of very acute symptoms, especially when accompanied with rapid emaciation, with or without intestinal disturbances, is of grave significance, although it must be borne in mind that in few diseases is the fluctuation between an apparent condition of great gravity and one of comparative comfort and well-being more often seen. The occurrence of acute mental symptoms, melancholia, mania, increases the gravity of the prognosis, and the sudden development of mania not infrequently marks the near approach of a fatal issue.

TREATMENT.—*General Treatment.*—The marked emotional disturbance so constantly present in exophthalmic goitre, and the influence of emotional excitement in temporarily aggravating its symptoms, suggest the necessity of so ordering the life that it may be as free as possible from sources of excitement. The use of all stimulants, alcohol in any form, coffee, and tea, should be interdicted. Physical exertion, except in great moderation, is not well borne, and patients suffering from the disease are rather injured than helped by travel. In cases presenting very acute symptoms with rapid emaciation a marked improvement is often effected by complete rest in bed, and Weir Mitchell's system of "rest cure"—isolation, rest in bed, hydrotherapy, and massage—is sometimes of benefit in my experience.

Medicinal Treatment.—The natural fluctuations of the disease, periods of improvement of varying duration alternating with a recrudescence of several or all of the symptoms, render a correct judgment of any system of therapeusis especially difficult. Clinical evidence, however, strongly indicates the usefulness of certain drugs—of belladonna,

[1] Charcot: *Gaz. méd. de Paris*, 1856, Oct. 20; Sousa-Leite: *Prog. méd.*, 1888, viii. 156; Joffroy: *Union méd.*, Paris, 1892, liii. 637.

of the bromides, and of the phosphates. The tincture of belladonna in ten-minim doses, given thrice daily, either alone or combined with ten or fifteen grains of the bromide of sodium or potassium, is often of distinct value. It is advisable to push the belladonna to the point of producing its physiological effects. The good results obtained from its use have been ascribed to its power of inhibiting to a greater or less degree the functions of secreting glands. Kocher[1] speaks highly of the value of the phosphate of sodium given in daily doses of one to two and a half drachms, and my own experience would corroborate this opinion. It should be given continuously over long periods of time. The glycero-phosphates, both of lime and of soda, when used, should be given in a daily dosage of forty-five to sixty grains. The valerianate of ammonia has been found to be of use occasionally.

The iodide of sodium or potassium in some cases is apparently of benefit, while in others their use seems to aggravate the symptoms. The syrup of hydriodic acid is a convenient and better form of administration in many cases. It should be given in half-drachm doses three times daily, well diluted and preferably before meals.

Digitalis and strophanthus apparently have little if any power to affect the increased heart action. The application of the ice coil or bag to the præcordium not infrequently ameliorates temporarily the cardiac symptoms.

As stimulants of general nutrition arsenic and strychnine are of use, and in cases associated with anæmia the arsenic should be combined with ferruginous preparations. An efficient combination and form is arsenous acid, gr. $\frac{1}{40}$, and Blaud's pil. mas. gr. x, to be given thrice daily after meals.

Murray strongly recommends the local use of the red iodide of mercury to reduce the size of the thyroid gland. A small portion of the ointment, the size of a pea, should be rubbed into the skin overlying the thyroid gland daily until the sensitiveness of the skin prevents its further use. After the interval of a few days the treatment should be renewed, and continued with necessary intermissions for weeks or months. Murray states that exposure to the rays of the sun increases the efficacy of the treatment, and that therefore the skin of the front of the neck should be exposed to the light as much as possible.

Although the administration of thyroid extract has apparently been beneficial in some cases, a marked increase in all the symptoms of the disease has so frequently occurred during its use that it cannot be recommended.

A very considerable number of cases have been reported by Owen, Mikulicz, Cunningham, Edes, McKie, Maude, Metcalf, Solis-Cohen, and Todd in which apparent benefit has been obtained from the use of thymus extract. In a very thorough review of the whole subject very recently Mackenzie[2] has expressed the opinion that the thymus extract has no specific value in exophthalmic goitre, but that it apparently exerts a stimulative effect upon the nutritive processes in general, and should be placed in the same class of remedies as cod-liver oil. Mackenzie's opinion is based upon a comparison of 20 cases of exophthalmic

[1] *Correspondenzbl. f. Schweizer Aertze*, 1895, i.
[2] *Am. Journ. Med. Sci.*, 1897, p. 132.

goitre which he has treated with thyroid extract and an equal number treated by other methods. In 2 cases which were kept under my continuous observation in hospital, while daily notes were recorded during a period of two months, the thymus extract being given in daily doses of sixty grains, representing a similar number of grains of the fresh gland substance, no benefit followed its use. There were the fluctuations of slight improvement and recrudescence of symptoms customary in the disease with or without treatment. In 1 case the thyroid gland increased an inch and a half in size, judged by the measurement of the neck, during the use of the extract. Booth of New York has had a similar experience in 4 cases. The daily dosage of the extract when used should not be less than sixty grains. The fluid extract or the tabloids are the most convenient forms for administration.

The electrical treatment of exophthalmic goitre has many warm advocates. Rockwell,[1] who has had a large experience, places a high value upon its power to ameliorate the symptoms or arrest the disease. He relies chiefly upon the galvanic current, using currents of from twenty-five to seventy-five milliampères. He claims that the maximum benefit is only attainable from currents of this strength. He has found sculptor's clay to be the best material for the composition of the electrodes, since it permits the use of currents of high power with a minimum surface irritation. The positive pole is placed over the sixth cervical vertebra and the negative over the region of the solar plexus, the positive being shifted to the thyroid gland during the séance. The positive clay electrode should be from two to three inches in diameter, and the negative five inches in diameter. The total duration of the application varies from two to five minutes. Other clinicians make use of galvanic currents of much weaker power, two to three milliampères.

Vigoroux[2] claims excellent results from the use of faradism. His technique is to apply the positive pole to the back of the neck, and the negative electrode, olive-shaped, over the carotid artery at the anterior border of the sterno-mastoid muscle, at the level of the angle of the jaw, for a minute and a half on each side. The negative electrode is then applied successively to the orbicularis palpebrarum, to the thyroid gland, and finally over the præcordium near the sternum in the third interspace. In the application of the negative electrode over the cardiac region the current is reversed. The whole sitting consumes ten or twelve minutes, and the treatment should be extended over a period of six to twelve months.

Surgical Treatment.—The growing disposition to treat exophthalmic goitre by surgical measures tends to the inquiry whether it is the best and most efficient treatment. In an attempt to answer this question the dangers of thyroidectomy or of extirpation by other surgical procedures must be carefully considered, as well as the degree of benefit which may be expected from operation.

In simple goitre the symptoms for which relief is sought are similar in character to those of exophthalmic goitre, although of less complexity and slighter in degree, and the record of Kocher alone indicates the slight mortality attending extirpation of the gland.

[1] *Med. Record*, 1893, Sept. 30; and *New England Med. Monthly*, 1896, 541.
[2] *Prog méd.*, 1887, vi. 316.

Notwithstanding his brilliant results, Kocher[1] at the meeting of the Congress of German Surgeons in 1895 expressed his hope that another treatment than a surgical one may be found for these cases. He even states that the results obtained by himself and his assistants by dietetic treatment and by the use of the phosphates had been sufficiently encouraging to emphasize this hope.

In well-developed exophthalmic goitre not only is the mortality much larger, but also the occurrence of alarming symptoms during and immediately after operation is not infrequent.

The occurrence of sudden death, which occasionally takes place during operation, has not as yet received a satisfactory explanation. Putnam suggested the rapid absorption of thyroid secretion from the cut surface of the wound, but now considers this explanation improbable.[2] The alarming symptoms consist in extreme prostration, excessive tachycardia, and dyspnœa, and to these may be added the occasional dangerous accumulation of mucus in the larynx and trachea.

Wette[3] considers injury of the recurrent laryngeal nerve to be the probable cause of some at least of these disturbances. As Putnam has pointed out, the seriousness of the tachycardia and dyspnœa may be more apparent than real, being no more than exaggerations of similar paroxysms often observed in cases not operated upon.

Nevertheless, an irritability and probable weakness of the heart, even in the absence of structural changes, in exophthalmic goitre must be fully recognized in deciding for operation.

The paralysis of the laryngeal muscles which frequently occurs after thyroidectomy fortunately disappears, as a rule—often, however, only after an interval of months.

Of the two operations chiefly advocated, ligation of the thyroid arteries and partial thyroidectomy, the former is earnestly advised by Kocher and Mikulicz in preference to resection, on account of its greater safety. Ligation of three arteries rather than of four is practised by Kocher. The observation has been made that every surgical measure which diminishes the size of the gland leads to its gradual further shrinkage or atrophy.

It is interesting to note that, as a rule, the longer the period of observation after operation the better appear the results. The psychoneurotic symptoms would appear to be among the first to subside; a marked diminution in the pulse rate occurs more gradually. The exophthalmos apparently may persist long after all other symptoms have disappeared—in fact, after practical recovery has been obtained. In 2 cases which have come under my observation such has been the case. In 1 operated upon by McCosh the patient was under my observation in hospital both before and after operation, and it is of interest to mention that there was a marked diminution in the degree of exophthalmos in the twenty-four hours succeeding the partial removal of the gland; there was no further improvement during the subsequent month. In the same interval the marked psychical disturbances had almost

[1] *Berl. klin. Woch.*, 1895, May 13.
[2] *Brain*, London, 1894, p. 214; *Journ. Ment. and Nerv. Dis.*, 1893, p. 799.
[3] *Arch. f. klin.-Chir.*, xliv. 792.

wholly disappeared, the tremor completely, and the pulse rate had fallen from 140 to below 100.

It would seem from a study of the operative cases that more rapid and greater benefit occurs in the majority of cases than under medicinal treatment. On the other hand, the high mortality rate up to the present time of the surgical treatment of exophthalmic goitre must exclude it as a routine measure.[1] It should be employed only, in my judgment, when all therapeutic measures have been fairly tried and have failed. The class of cases in which surgical treatment would seem especially advisable or indicated are those of not too long duration and with symptoms sufficiently severe to produce disability.

Inasmuch as it is claimed that the surgical treatment of certain pathological processes elsewhere in the body (polypi and other disease products in the nasal passages—Spicer, Stoker,[2] Winckler,[3] Fränkel,[4] Semon[5]), sometimes causes the symptoms of exophthalmic goitre to subside or disappear, the removal of such sources of irritation may be recommended.

Tuberculosis of the Thyroid Gland.

Primary tuberculosis of the thyroid gland is exceedingly rare. Bruns[6] has reported a single personal case, and has collected 6 others. In 5 of these isolated nodules were present, without enlargement of the gland.

On the other hand, secondary invasion of the thyroid in chronic tuberculosis is comparatively frequent. Chiari[7] found it in 7 cases out of 100, and Fränkel in 6 out of 50. In acute miliary tuberculosis Fränkel[8] has invariably found tubercles in the thyroid gland.

Hydatid Disease of the Thyroid Gland.

Hydatid disease is also a rare affection of the thyroid gland. Henle[9] has collected 21 cases, in 5 of which, however, the diagnosis was not a positive one. The diagnosis is difficult without exploratory puncture, which should always be employed, Henle advises, in cystic cases.

The treatment consists in free incision, with evacuation of the contents of the cysts, the prognosis then being good.

Malignant Disease of the Thyroid Gland.

Both *sarcoma* and *carcinoma* are among the rarer affections of the thyroid gland. Carcinoma is more common than sarcoma. Both forms are more liable to develop in a goitrous than in a normal gland. As in other forms of malignant disease, their occurrence is more common between forty and sixty years of age than at other periods of life. Weir suggests the position of the cervical vessels as a possible means of differentiation between benign and malignant enlargements of the

[1] In the 187 cases collected the mortality rate was 7 per cent.
[2] *Brit. Med. Journ.*, 1894, ii. 1110.
[3] *Wiener med. Woch.*, 1892, 1521.
[4] *Berl. klin. Woch.*, 1888, 111.
[5] *Internat. Centralbl. f. Laryngol.*, vi. 238.
[6] *Beiträge f. klin. Chir.*, 1893, vol. 10, p. 1.
[7] *Med. Jahrbuch.*, 1878, S. 69.
[8] *Virchow's Arch.*, vol. 104, 1886, S. 58.
[9] *Archiv f. klin. Chir.*, 1895, vol. 49, p. 852.

gland: "a benign tumor of sufficient size pushes them before it, a malignant tumor grows about them." The frequent infiltration of the surrounding tissues through which the tumor is prevented from moving upward in the act of swallowing he regards as a sign of greater value.

The average DURATION of life in cancer of the thyroid is from six months to a year.

Published reports of the results of excision of the diseased gland, the only TREATMENT which offers any possibility of relief, indicate at once the formidable character of the operation and the great mortality attending it.

CRETINISM AND MYXŒDEMA.

By M. ALLEN STARR, M. D.

Cretinism and myxœdema are diseases of nutrition produced by a defective action of the thyroid gland. Cretinism is due to an imperfect development of the gland, and is congenital in origin. Myxœdema is an acquired condition which may be developed at any age, and may be produced by a sudden or gradual spontaneous arrest of function of the thyroid gland, or by its actual destruction by disease, as in goitre, or by its total removal from the neck.

CRETINISM.

Etiology.—Cretinism is endemic in certain regions of the world. It prevails in those localities in which goitre is common, and stands in a direct causal relation to it. Goitre and cretinism occur with especial frequency in mountainous regions, and more particularly in certain valleys among the mountains. Thus in Switzerland there are 209 cretins to every 100,000 inhabitants, but in some valleys the number is as high as 16 per 1000 inhabitants. In Savoy, among 900,000 inhabitants, 40,000 are afflicted with goitre, and there are 14,400 cretins. In Northern Italy there are 205 cretins to 100,000 inhabitants; in the Tyrol, 105 to 100,000. In these districts about 40 per cent. of the cretins come from parents who are afflicted with goitre. In a considerable number of cases of endemic cretinism goitre is present. Cretinism is also endemic in the highlands of China and among the Himilaya Mountains in India and the Andes of South America. It is also found in the mountain valleys of Central America and Mexico. It is not endemic in any part of the United States. Cretinism is never endemic in low-lying countries or along the sea-coast. It has, however, been known to become endemic for a few years in certain valleys in England, and then to disappear entirely. Thus in Somersetshire, in 1847, there were 35 cretins in a little town of 500 inhabitants, but at present there are no cases to be found there.[1]

It is generally agreed that there is a direct causal connection between certain qualities of the drinking-water in those regions where cretinism and goitre are common and these diseases, but the exact quality of the water which produces this disease is not determined. Ewald affirms that the water alone is not the only cause of the disease, as

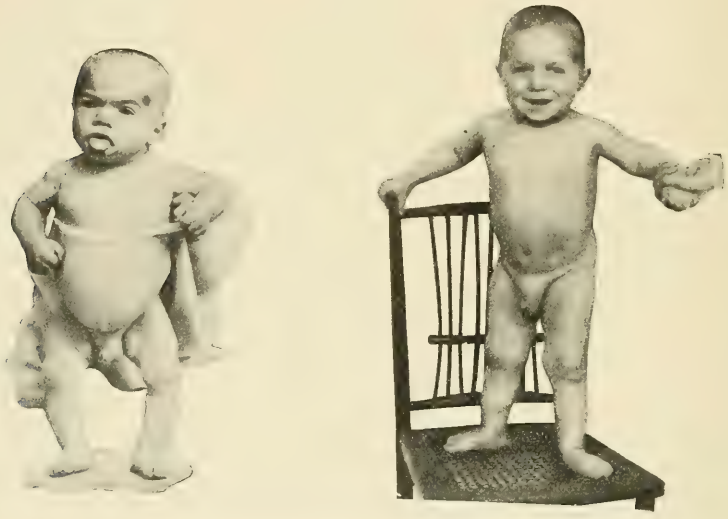
[1] A. Hirsch: *Kropf und Cretinismus, Handbuch der geographischen Pathologie,* Stuttgart, 1883; H. Bircher: *Die Verbreitung des Kropfes im Mittel Europa,* Basel, 1883; V. Allara: *Der Cretinismus,* Leipzig, 1894.

many escape, but that imperfect hygienic and social conditions and certain hereditary influences acting upon the individual coincide to act with the water as causative factors in the disease.[1]

Sporadic cases of cretinism are found in all parts of the world, and are not very rare in this country, being, however, less common than in Europe or China. Osler has recently collected 60 cases.[2] The disease appears without relation to the existence of goitre in the parents, and in the majority of cases no explanation for the defective development of the thyroid gland can be obtained. Cases are not more common in mountainous regions than in the cities on the sea-shore. They are rarely associated with goitre.

Symptoms.—The symptoms of mal-development are noticed by the parents at about the sixth month, when it is found that the child is not growing as rapidly as it should, is not developed in point of intelligence, has a peculiar swollen appearance of the face, and has a tendency to keep the mouth open constantly with slight protrusion of the tongue. These features are shown in the photographs of cases here presented.

Fig. 34.



A typical cretin before and after treatment (Dr. Osler's case).

As the months go on it does not develop either physically or mentally as other children do; it remains stunted in its growth, the bones being short and rhachitic, but it is very fat; the skin is apparently swollen, though it does not pit upon pressure, lies in folds on the forehead, face, neck, and body, is exceedingly dry and often scaly. The hair does not grow properly upon the scalp, and often falls, leaving the child almost bald. The eyes are not fully opened. It makes no attempts at walking or talking, and is not uncommonly subject to convulsions. The child has difficulty in swallowing anything but liquid food. Its digestion is

[1] C. A. Ewald: *Die Erkrankungen der Schildrüse, Myxœdema und Cretinismus*, Wien, 1896.

[2] *Amer. Journ. Med. Sci.*, Oct., 1897.

FIG. 35.

A typical cretin before and after treatment.

FIG. 36.

Normal child, aged four, and his two brothers, aged nine and eleven, cretins showing contrast in size.

often impaired, with a tendency toward obstinate constipation. Examination of the blood has shown a fœtal state of the red corpuscles. They are small, 3.13μ in diameter, and are nucleated. Under the thyroid treatment Krapelin and Libreton have seen this condition disappear, the corpuscles increasing in size to 7.5μ, and becoming normal in appearance.

FIG. 37.

Children of one family, aged one and one-half years, nine years, and eleven years (Dr. Caverly's cases).

FIG. 38.

Dr. Caverly's cases after one year of thyroid treatment. (The same children as in Fig. 37.)

The mental defect often attracts attention earlier than the physical condition, and at the end of the second year the child may be in the mental state of an ordinary child at six months, not having attempted to talk or to stand alone. Fig. 36 shows three children of a family, one

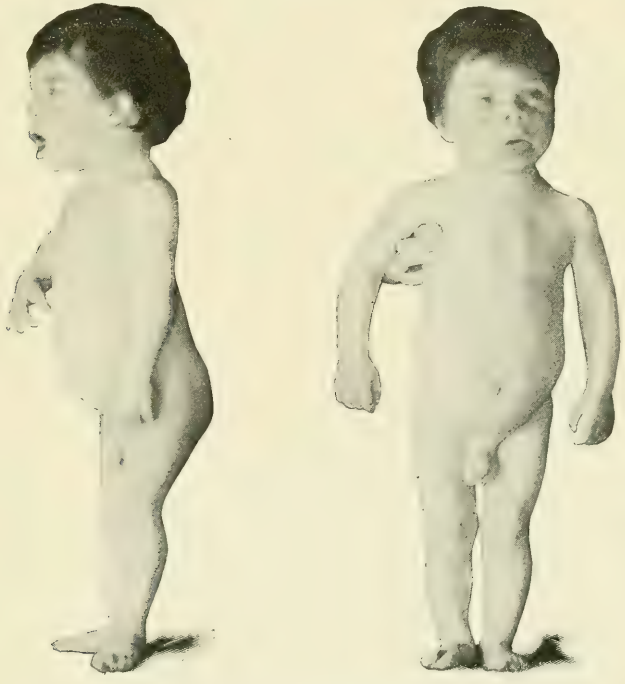
PLATE I.

Negro Cretin, aged eight years.

normal, the other two cretins, and it will be seen that the normal child at the age of four is much taller than either of the other children at the age of nine and eleven. If these children are not treated by giving them thyroid extract, they remain dwarfs and imbeciles during their entire lifetime. Their grade of intelligence is very low. Their speech is very imperfect, almost entirely confined to monosyllables. Their physical stature remains below three feet, though their bodies are much stouter than they should be at that height. They do not develop sexually. The skin is thrown into folds and ridges, so that the face looks very old, and is exceedingly repulsive on account of the imperfect opening of the eyes, the heaviness of the cheeks, and the protrusion of the tongue, which has led to these faces being selected in times past to serve as models for gargoyles in many of the buildings of the Middle Ages. The absence of the gland does not appear to decrease the length of life or to render the individual more subject to disease, and in Switzerland many cretins are to be seen who have passed the age of sixty.

Cretinism is rare among negroes, but Plate I. shows a case observed at my clinic, and now entirely well.

FIG. 39.

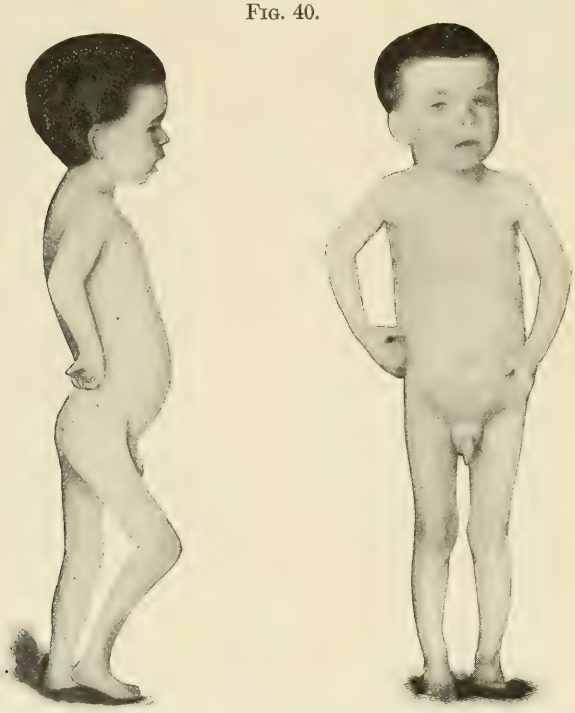


A typical cretin, aged seven years.

TREATMENT.—Under the modern treatment by the use of the thyroid extract this condition can be very much improved, and in some cases entirely relieved, the continued use of the extract being attended by a rapid increase in the growth and development of the child; by a reduction of the fat, so that within a year the child's body is that of a

normal infant or child; by a rapid growth of all the tissues; by an awakening of the intellect and a rapid change from a state of imbecility to that of moderate mental activity. The amount of the remedy that is necessary to be taken varies in different cases. It is best to begin with a small amount—one grain of the solid extract daily in divided doses, and to increase the dose each day by one-tenth of a grain until the point is reached at which a rise of temperature is obtained or the pulse becomes unduly accelerated. When this point is reached it is well to keep the dose just below that which produced the rise of temperature,

FIG. 40.



The same boy shown in Fig. 39, after one year of thyroid treatment.

and as the child grows it is necessary to gradually increase this dose in accordance with its body weight. When the exact dose needed is determined, it is well to divide it into three parts and give it with each meal. The figures show the changes in children under this treatment attained in the course of a year.

MYXŒDEMA.

ETIOLOGY.—Myxœdema in the adult may be caused by a number of different conditions. There are a number of cases which are due to the removal of the thyroid gland for the relief of goitre, and this is now so well known that surgeons in the removal of a goitre at present take pains to leave a small amount of the glandular tissue, inasmuch as even

a small amount is found sufficient to prevent the development of the disease. Secondly, myxœdema may be produced by any form of disease of the gland which results in the destruction of its glandular tissue. Thus in some forms of goitre or of tumors of the thyroid gland, where the tissue of the gland is replaced by new tissue, symptoms of myxœdema may gradually develop as the action of the gland ceases. This is, however, a rare complication of the ordinary forms of goitre, for, as already stated, a small amount of glandular tissue is all that is necessary to maintain the ordinary nutrition of the body, and in goitre it is very rare for the entire gland to be destroyed. Myxœdema may also occur from a gradual atrophy of the gland from unknown causes. The disease is much more common in women than in men (7 to 1). There seems to be a tendency to a retrograde change of the glandular tissues in women at the time of the menopause; hence it is at this time that the disease sometimes appears, although no age is exempt from the affection. It is now believed that many of the irregular nervous and vascular symptoms attendant upon the menopause are actually due to changes occurring in the thyroid gland—in some cases a suspension of action, in others an excess—(possibly in other glands also), in addition to the changes in the ovaries; and it is an undoubted fact that the treatment of these symptoms by thyroid extract has been of considerable service in the first class of these cases.

There does not appear to be any particular relation between climate, altitude, or season of the year in the development of myxœdema, nor is the disease more common in the countries in which cretinism is endemic. It is a comparatively rare disease, though it is probable that it has escaped observation and diagnosis until recently, when the renewed interest occasioned by its successful treatment has attracted more attention to it. It has been found to be present in several members of a family in some cases, but inheritance is not established as a causal factor. Ewald states that a nervous heredity is to be found in 30 per cent. of the cases. The age of maximum liability is thirty-five to fifty, but it has been observed at all ages.

Pathology.—The essential lesion in myxœdema consists of a fibroid change in the thyroid gland, producing a progressive atrophy of its glandular elements and a suspension of its function. Thus in a case described by Hun and Prudden,[1] from which the accompanying figures are taken, the thyroid gland was found very small, measuring from one third to one half an inch in each lobe, and a large proportion of the atrophied gland was made up of dense connective tissue, as shown in the figures (Figs. 41, 42). In another case, also examined by Prudden,[2] the capsule of the gland was thick and dense, and the thickened capsule merged imperceptibly into the dense interstitial tissue of the gland, which was greatly increased everywhere in proportion to the parenchyma. Thus the interstitial connective tissue occupied from one half to two thirds of the section area in all parts of the gland, and was dense and fibrillar, and contained numerous thin-walled bloodvessels. Fusiform and small spheroidal cells were scattered in moderate numbers among the fibres, and in some places the connective tissue about the bloodvessels was densely infiltrated with small cells. In the paren-

[1] *Amer. Journ. Med. Sciences*, July, 1888. [2] *Loc. cit.*, p. 16.

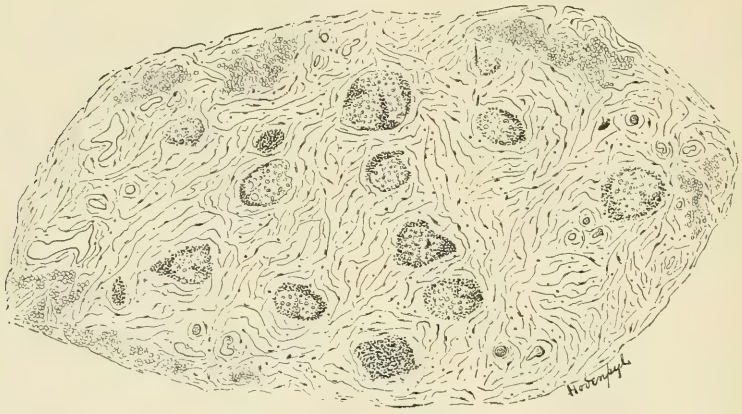
chyma of the gland the most marked changes had occurred. Scattered here and there throughout the atrophied gland were little islets of gland tissue, the largest from three to four millimetres in diameter, the small-

Fig. 41.

Lesions of the thyroid gland in myxœdema (Hun and Prudden).

est scarcely visible to the naked eye, composed of a congeries of large and small rounded but irregularly shaped vesicles, which were either regularly lined with granular flattened or cuboidal epithelium, or com-

Fig. 42.



Lesions of the thyroid gland in myxœdema (Hun and Prudden).

pletely filled with a multiple nucleated granular cell mass or a clump of irregularly shaped cells (Fig. 43). The vesicles or cell cavities possessed a very thin membrana propria, and were surrounded by a regular capillary network. These masses of vesicles apparently represented the lobules of the thyroid. A few of the larger vesicles contained colloid material. Thus there was a destruction and granular disintegration of the glandular elements of the gland, with a great increase in the amount of connective tissue and a progressive atrophy of the entire gland. (See Fig. 44.)

This is the essential lesion of myxœdema, and, while many changes described as mucoid degeneration and deposits of mucin are found in all the organs in patients who have died of the disease, such changes,

FIG. 43.

Lesions of the thyroid gland in myxœdema (Hun and Prudden).

FIG. 44.

Lesions of the thyroid gland in myxœdema (Hun and Prudden).

together with the condition of endarteritis and increase of interstitial connective tissue commonly present, must be considered as secondary lesions, and not as forming an essential part of the pathology.

Symptoms.—The symptoms of myxœdema are very numerous, as almost all of the organs of the body may be in some way interfered with during the course of the disease. There is no precise order in the development of these symptoms, and no one case manifests all the varieties that may be present; hence it is impossible to give any description of a typical course of a case of myxœdema, and it is necessary to discuss the symptoms in order, without reference to their particular period of development.

1. *Changes in the Skin.*—The alteration in the appearance of the patient is the most noticeable feature of the disease. The skin is

Fig. 45.

A typical case of myxœdema.

changed in its thickness, color, and appearance. It is dry and scaly, so that in many patients there is the appearance of the body having been powdered, and the patients complain that they never perspire and that the skin is always rough and harsh to the touch. If patients are not careful in the care of the skin, this scaly condition leads to the formation of more or less extensive crusts, and consequently to cracking of the surface, which is more noticeable about the hands and feet than elsewhere upon the body. In addition to the dry, scaly character there is a brown pigmentation of the skin, which is more noticeable upon the hands and feet, but is present in many parts of the body as

well, leading to a dirty appearance, especially of the forehead and back and upon the extensor surfaces of the limbs. This is evident in the patient shown in Fig. 45. The skin is manifestly thickened, and this is due, as post-mortem examination has shown, to the existence of mucin deposits in the dermal connective tissues. This thickening is not simply apparent, but evident to the touch. The thick skin can be indented by the examining finger, and is not hard as in scleroderma, but it does not pit upon pressure, resuming its contour immediately after the pressure is removed; hence the œdema is readily distinguished from the ordinary œdema of Bright's disease or of dropsy. The thickening of the skin is most marked in certain localities of the body. It is usually evident that the scalp is unduly thickened, and it is in the hair

FIG. 46.

The same patient as in Fig. 45, after four months of treatment by thyroid extract.

of the scalp that the scaly crust accumulates to which reference has already been made. A thickening also occurs upon the cheeks just anterior to the ear, so that there is apparently a little pad of fat over the parotid gland. A thickening is noticeable in the naso-labial folds, hence the contour of the nose is changed. There is usually a slight permanent dilatation of the capillaries of the cheeks over the malar bones, giving the face of the patient an attractive high color which contrasts markedly with the yellowish pallor of the rest of the skin, and leads the observer at first to suppose that there has been an artificial coloring of the face. Very frequently the skin of the forehead is thickened, and the lines upon the forehead are developed early and are

quite deep. They are more noticeable at the sides than in the middle of the forehead, on account of the slight tendency to an elevation of the external corner of the eyebrow which is present in almost all cases. The lips are much thickened, giving an extremely coarse appearance to the face, and on account of this thickening of all the tissues of the face there is a lack of play of feature, and hence an expressionless appearance resembling that of dementia. The thickening of the skin is also very evident in the triangles above the clavicles, where a distinct pro-

FIG. 47.

Patient with myxœdema (Dr. Meltzer's case).

FIG. 48.

The same patient after thyroid treatment.

trusion or pad of fat is to be found. These thickenings are demonstrated in the photographs (Figs. 45, 47). Similar thickenings resembling lipomata are often observed in other parts of the body, especially in the flexion of the elbow, in the popliteal spaces, and about the ankle. The thickening of the skin is also noticeable over the surface of the abdomen, and here patches of discoloration and pigmentation are commonly to be found. On account of this general thickening of the skin and subcutaneous tissues the patients have, as a rule, the appearance of obesity. All these features are well shown in the photographs of patients (Figs. 45, 47).

There is a tendency to a falling of the hair in this condition. The hair of the scalp is dry, brittle, and thin, many patients being noticeably bald; and the hair from all other parts of the body, from the eyebrows and especially about the genitals, falls early in the disease. Under the course of treatment a growth of new hair always occurs, so that after a year of treatment the scalp may be covered with new hair, even in a person who has been bald for some years. This is shown in Fig. 52. The growth of the nails is sometimes impaired; they may be thick, ridged, and brittle.

FIG. 49.

Patient with myxœdema.

FIG. 50.

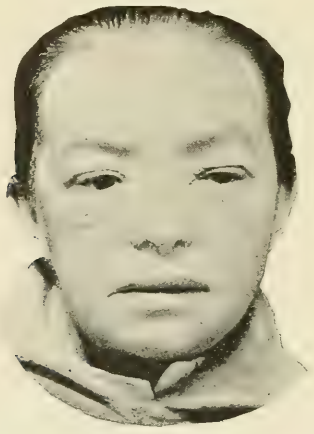
The same patient after three months' treatment.

A suspension of the action of the sweat-glands is an accompaniment of the changes in the skin, and hence these patients do not perspire even in very warm weather or upon exertion. They suffer constantly from a sensation of cold, and even in the warmest summer day these patients are merely comfortable, never being oppressed by heat.

2. *Changes in the internal organs* consequent upon the deposit of mucin result in the production of very numerous symptoms. There is usually a thickening of the conjunctiva and of all the mucous membranes; hence there is obstruction to breathing through the nose, susceptibility to laryngeal and bronchial affections, with more or less difficulty in breathing, often supposed to be of the nature of hysterical respiratory spasm, disturbance at times in the act of swallowing, and intestinal indigestion, with liability to dyspepsia, to obstinate constipation, and to attacks of diarrhœa. A thickening of the mucous membrane of the rectum forms another factor inducing constipation. A very marked thickening and swelling about the genital regions is present in women. The tongue is thickened, and hence the speech is affected in a manner which is characteristic, being thick, indistinct, and of a lisping quality.

3. The *action of the kidneys* is also affected very markedly in this disease, and this fact has led to the diagnosis of chronic Bright's

FIG. 51.



W. Gilman Thompson's case of myxœdema.[1]

disease in a considerable number of the cases. The urine, as a rule, is scanty, of a medium specific gravity (1018 to 1024), and sometimes contains albumin in considerable amount, and fatty, hyaline, and granular casts. The percentage of urea is usually diminished. This condition of the urine, taken in connection with the apparent œdema of the skin already mentioned and with the nervous symptoms soon to be described, has naturally led to the supposition that the patient was suffering from chronic Bright's disease. It is found, however, that

[1] *Trans. Assoc. Amer. Phys.*, vol. viii. p. 373.

under the treatment by thyroid extract all these symptoms of nephritis disappear.

4. The *sexual functions* are markedly diminished in this condition, and in women menstruation is usually suspended or is extremely irreg-

Fig. 52.

Same patient as in Fig. 51, three weeks after beginning thyroid-extract treatment.

ular, with very large hemorrhages at intervals, but without other signs of uterine or ovarian disease.

5. The *nervous symptoms* are the most acute and intense, next to those of the skin. The *mental condition* of these patients is always abnormal. In fact, it is their mental condition that in many cases leads them to consult a physician. They appear to become slowly but progressively demented. There is a lack of quickness of perception of things about them; a slowness in the ordinary train of thought; a lack of interest and a general condition of emotional depression, in some cases amounting almost to a state of melancholia; and a sluggishness in the performance of all acts of mind and body. These patients take little interest in things about them, sitting in a listless, idle way, without occupation for days; show no pleasure in their family and surroundings, and are depressed at their own indifference and inability to concentrate the mind. They are very commonly subject to hallucinations. These hallucinations are usually of sight and of hearing, though occasionally hallucinations of touch (paræsthesiæ) and of smell have been recorded. Hallucinations may be so frequent as to constantly occupy the attention and interfere with the mental processes, and they are very common at night, producing insomnia. Since general interest has been excited in myxœdema a number of patients suffering from this disease have been discovered in various asylums to which they had been committed for chronic dementia or chronic melancholia. It is to be remembered, however, that they are not really suffering from either of these diseases, for there is not the constant continued depression usually present in melancholia. There is, as a rule, no delusion of self-reproach; there is no tendency to suicide; there is none of the characteristic insomnia of melancholia which occurs early in the morning, and these patients

can, as a rule, be diverted from themselves by a little effort. Nor is their demented state exactly that of ordinary dementia, for they can be aroused to interest themselves, and although the memory is impaired, it is not lost, and although the judgment may be somewhat defective, yet it is not as manifestly so as in ordinary cases of dementia. All these mental symptoms are found to disappear progressively under the treatment with thyroid extract, so that the patient's mind is completely restored. This indicates that there has been no actual destruction of brain tissue, but only a suspension of activity during the disease.

The *sensibility of the body* is very often altered in myxœdema. Perceptions of heat and cold are interfered with to some extent, though this may be due to the depressed temperature of the body generally, and tactile sensations are very often disturbed, there being prickling, tingling, and numbness felt in various parts of the body, which may be due to local pressure upon the nerves from deposits in the tissues or to irritation of the brain producing hallucinations. Pain is felt at irregular parts of the body, and is also, in all probability, of an hallucinatory nature. Considerable *weakness* is observed in many of these patients, though it does not often go on to the degree of paralysis. They frequently drag the limbs in walking, are unsteady in their gait, cannot walk any distance without becoming exhausted, and are unable to go up stairs or to make any continued physical effort. This condition may be due to an actual weakening of the muscles from a deposit of mucin in their tissues, or is, more likely, caused by an inability to exert the voluntary motor centres in the brain. Reflex activity and the automatic acts of the body do not appear to be interfered with, as a rule, in myxœdema.

Convulsions occasionally occur, especially in children, which in the absence of any cause have been erroneously considered as epileptic. They are rarely observed among adult patients. Headache and vertigo are not uncommonly complained of, and are sometimes very severe.

The *temperature* of the body is uniformly depressed from $\frac{1}{2}^\circ$ to $1\frac{1}{2}^\circ$ F., and the patients suffer from a continued sense of cold.

The *circulation* is usually normal, but occasionally the pulse is slow. The arterial tension is not increased, but the pulse is often small and feeble. In all the cases recorded a perceptible atrophy of the thyroid gland in the neck has been mentioned.

Diagnosis.—The appearance of a patient suffering from myxœdema is so characteristic that there is very little difficulty in making a diagnosis by inspection. There is but one disease which is likely to be mistaken for myxœdema, and that is the condition of chronic nephritis. The cachectic appearance, the yellowish color of the skin, the swollen face and extremities, the dryness of the skin, and the occurrence of albumin and casts in the urine have led many observers to make the diagnosis of chronic nephritis when the disease present really was myxœdema. The fact that in both diseases a general malaise and fatigue upon slight exertion, headaches, insomnia, and mental incapacity for work, and digestive disturbances are present, has given additional reason for this mistake. There are certain facts, however, which enable one to distinguish these two diseases quite sharply from one another. In nephritis œdema occurs as a symptom under two conditions: First, in acute nephritis, in which it is associated with a scanty urine of high specific

gravity, large amounts of albumin, and many casts, under which circumstances the general symptoms are intense, the œdema quite extreme. In this condition the œdema is especially located in the legs, and is governed not a little by gravitation, being more marked in the dependent parts of the body—in the back if the patient is in bed. When the face is œdematous, the upper eyelid is affected as well as the lower, but it does not cause any thickening of the bridge of the nose, of the lips, or of the tongue; hence there is no disturbance of speech as in myxœdema. It will be remembered that the chief swellings in myxœdema are over the masseter muscles and in the supraclavicular spaces; that the œdema is quite uniform upon the body, and more noticeable upon the abdomen than on the back; that it is not affected by gravitation, and hence the legs are not more affected than the arms, and the soft parts are not particularly swollen. Finally, in myxœdema there is no pitting upon pressure, and no evidence of fluid beneath the skin which can be displaced by manipulation.

Aside, then, from the fact that the slow onset and gradual course of the case in myxœdema contrast markedly with the acute onset and severe symptoms of acute nephritis, it is possible by an examination of the œdema to distinguish between these diseases.

The second form of nephritis in which œdema occurs is chronic nephritis with contracted kidneys, hypertrophied heart, and increased arterial tension. In this condition the urine is excessive in amount, of low specific gravity, contains traces only of albumin and a few hyaline and granular casts. The symptoms are of slow onset, chiefly cerebral and gastric in nature, and a cachectic, pale appearance is present. In this form of nephritis the œdema is slight. It is uniformly noticed along the tibiæ and in the ankles after standing. It never affects the hands and arms. If it appears in the face, it is under the eyelids, and never upon the forehead, cheeks, or lips. The same condition of the urine may be present in myxœdema, and many of the same symptoms may also be found. It is to be remembered, however, that the skin in myxœdema is not only discolored, but is uniformly dry and does not perspire, and that it is in a state of active desquamation, so that the patients have the appearance of being recently powdered. In myxœdema the skin is not thin, smooth, and glossy, as it may be in nephritis, and in nephritis there is wanting the high color of the cheeks which has sometimes led to the idea that patients with myxœdema were rouged. Again, in chronic nephritis there is no change in the condition of the hair, which in myxœdema is thin, coarse, bristly and dry, and falls easily. In nephritis there is no uniform depression of the temperature below normal, nor do the patients feel the sensation of cold constantly as they do in myxœdema. While patients with nephritis often have headaches and are disinclined to mental application, they do not suffer from the hallucinations, general depression, defects of memory, and inability to use the mind which are characteristic of myxœdema.

It is evident, therefore, that a careful study of the symptoms in these two conditions will enable a differentiation to be reached.

Prognosis.—The prognosis in myxœdema since the discovery of the thyroid treatment is uniformly favorable. Treatment by thyroid extract results in a gradual subsidence of all the symptoms, both physical and

mental, and a gradual return to health. When this is reached, it can be maintained by constant supply of the thyroid extract, and so long as the patient continues its use a normal state of mind and body can be maintained. My personal experience of this result extends to 15 cases, and Murray, who is the originator of this line of treatment, reports that patients never fail to improve.[1]

TREATMENT.—The treatment of myxœdema consists in supplying the body with those materials which are normally furnished by the thyroid gland and which are lacking in the condition of myxœdema.

Space does not permit an historical review of the development of this line of treatment, but reference must be made to the work of Horsley, Kocher, Murray, and Mackenzie, to whom the successful application of the facts derived from experimental physiology in the treatment of this disease must be credited. The use of raw thyroid chopped, given to the patients in the form of sandwiches, and of hypodermic injections of glycerin extracts of thyroid gland, has been finally superseded by the use of solid extracts, which are now prepared by various makers and put up in the form of tablets. Although attempts have been made to isolate various substances from the gland which have been supposed to be its active principles (thyreoidin), it is not yet possible to determine the exact effect of these, and hence at present the treatment consists in the administration of solid thyroid extracts in the form of tablets or powders. The strength of the various preparations put up by different firms varies greatly, hence it is necessary to mention the various preparations in use. A careful series of observations upon the same patients treated by different preparations has led me to the conclusion that the relative strength of the various preparations is in the following order: Fairchild's (New York) tabloids, 5 gr., 1; Armour's (Chicago) capsules, 5 gr., 2; Parke, Davis & Co.'s (Detroit) 5-gr. tablets, 2; Burroughs, Welcome & Co.'s (London) tablets, 5 gr., 3.

The Fairchild tabloid is taken as a unit of strength, though it is very much weaker than the English tablet or than the five-grain capsules or tablets of the other American firms mentioned. This, however, is a convenience and not a defect, inasmuch as the necessary dose of the extract varies in different individuals widely, and it is frequently found that a single tablet of the greater strength is injurious. In the treatment of any case of myxœdema it is well to begin with a small dose—namely, one Fairchild tabloid three times a day with the meals. If other preparations are selected, it is necessary to bear in mind their relative strength, and to begin with one English tablet or with a capsule of five grains of the other preparations once a day, preferably at night. After three days, if there has been no increase in the rapidity of the pulse, no rise of temperature, no increase in the rapidity of respiration, it is well to increase the dose. Day by day one more tabloid of the Fairchild preparation may be given, watching for the signs of ill effect. They appear, as a rule, when nine tabloids are taken daily, the equivalent of three English tablets or fifteen grains of other extracts. It is not well to begin with the larger dose at first, since numerous cases are on record in which acute poisoning has occurred from an overdose of thyroid. When the point is reached at which a slight rise of tem-

[1] *Twentieth Century System of Medicine*, vol. xvii., Wm. Wood & Co., 1896.

perature and a slight increase in the rapidity of the pulse appear, it is evident that the patient is getting too much of the thyroid, and the dose must be decreased to the amount just insufficient to produce these effects. This dose should be maintained for at least two months, during which time all the symptoms will gradually disappear. It is necessary to watch, however, for unfavorable effects, especially for a rise of temperature or a weakening of the heart, and if these appear the dose must be decreased. If improvement is not progressive enough, it is because the dose is not sufficiently large, and it may have to be increased. The relative strength of the different preparations has been insisted upon because there is manifest danger in changing the preparation if the same dose is maintained. Thus in a child who was taking three Fairchild tabloids daily, serious poisonous effects were produced by the administration of one Armour capsule, whose strength was twice that of a Fairchild's tabloid. It seems more reasonable to supply the thyroid in small amounts at intervals during twenty-four hours, thus imitating the natural supply, than to administer a large amount but once. After the patient has entirely recovered from the symptoms of the disease, and has returned to a state of health, the amount of thyroid necessary to preserve health must be determined in each case by experience. I have some patients who require but one Fairchild tabloid daily; the majority require three Fairchild tabloids daily. There are cases upon record in which one Fairchild tabloid twice a week suffices to maintain a state of health. The ill effects produced by the use of thyroid in excess are rapid heart action, rise of temperature, general pains in the bones and joints, flushing of the skin, profuse perspiration, diarrhœa, general nervous excitability, prominence of the eyeballs, and convulsions. It will be noticed that these are the ordinary symptoms of exophthalmic goitre, and it is their occurrence in patients suffering from myxœdema to whom too much thyroid has been administered which has led to the prevalent theory that exophthalmic goitre is due to an excess of thyroid secretion. In a case of serious poisoning from an overdose of thyroid extract strychnine, digitalis, and atropin may be used as antidotes.

Dr. Gordon Paterson has recently published[1] the interesting fact that a woman who had given birth to two cretins was fed upon thyroid extract during her third pregnancy, and gave birth to a healthy child.

The remarkable effect of this treatment is demonstrated in the photographs of patients before and after treatment. All of these patients have been under my personal observation. I desire to express my indebtedness to Dr. Caverly of Rutland, Vt., Drs. Meltzer and Woodruff of this city, and to Dr. Osler of Baltimore for permission to publish the pictures of their patients.

[1] *Lancet*, Oct. 2, 1897.

CHRONIC METAL-POISONING; ALCOHOLISM; MORPHINISM.

CHRONIC METAL-POISONING; ALCOHOLISM; MORPHINISM.

CHRONIC METAL-POISONING.

By FREDERICK G. FINLEY, M. D.

CHRONIC LEAD-POISONING.

Synonyms.—Plumbism; Saturnism.

Etiology.—Chronic poisoning by lead is commonly found in those engaged in industrial persuits in which this metal or its compounds are employed. It is, however, not infrequently met with from the continued accidental absorption of small quantities of lead. The metal usually reaches the system by the alimentary canal, but is also absorbed by the lungs, skin, and mucous surfaces.

The continued ingestion of lead itself, its alloys, or its salts may cause toxic symptoms. Workers in carbonate or, as it is known in commerce, white lead are particularly liable to be attacked severely and rapidly, owing to their work being in an atmosphere impregnated with this compound in the form of fine dust.

As with other toxic agents, there is a marked personal predisposition, certain individuals being much more liable to suffer than others. For the most part, we are ignorant of the cause rendering certain individuals so susceptible. Although men are more commonly attacked, owing to their more frequent exposure, yet women are more susceptible if placed under similar circumstances. Oliver, in an epidemic of lead-poisoning due to polluted water in Yorkshire, found that the ratio of men to women affected was as 4 to 1. Children, again, are more susceptible than adults.

Stewart, in a number of cases due to mixture of lead chromate with flour, found a large majority of those affected were children.

Painters suffer more frequently than any other class. Lead is a frequent constituent of glass, so that glass-grinders and glaziers are occasionally attacked. Among printers it is now seldom found. File-cutters, who use a leaden cushion on which the file is struck, are at times affected, as are also leather-cutters, who work on a leaden slab. Rollers of sheet lead, shot-makers, casters of type and of leaden toys are also affected by the direct absorption of the metal itself. Among potters those known as dippers, whose duties require them to immerse the hands in a solution containing lead, are frequent sufferers. Lead-

smelters and miners may suffer, the former from the fumes and the latter from dust. Miners are, however, seldom attacked, and, according to Oliver,[1] they never suffer in the mines in Derbyshire. Lead is used in the manufacture of oilcloths and linoleum and in rubber-factories, and cases of lead-poisoning occasionally occur in those employed in such manufactories.

Apart from industrial pursuits, the source of lead-poisoning is frequently difficult to discover, and, particularly in women, it may baffle all our efforts. It may, however, be taken as a general rule that the metal is much more frequently ingested with fluids than with food. In wine-growing countries sugar of lead was formerly often used to improve poor wines and prevent them from souring. Numerous cases of illness following this practice led to enactments being passed against it by German sovereigns in the fifteenth century. Cider or beer which has been in contact with leaden pipes or stoppers has frequently been the cause of lead colic, and recently a number of cases have occurred from the use of aërated waters in which leaden stoppers were attached to the under surface of the cork. Drinking water contaminated by leaden cisterns or pipes is a common source of poisoning. Fortunately, however, certain salts contained in most drinking waters prevent the solution of lead. The well-known case of Louis Philippe and his household, where not more than .0015 per cent. of lead was present in the drinking water, illustrates how small a quantity of the metal is required to produce symptoms, provided its ingestion extends over some period of time. Acid fruits cooked in glazed earthenware vessels, certain canned articles of food, snuff or tobacco contained in leaden foil, cosmetics containing lead, and even the use of a leaden comb, have all proved the source of toxic symptoms. Küster records a case in which a bullet after being imbedded in the body for seventeen and a half years produced lead-poisoning. Toxic symptoms have occurred from biting off yellow thread colored with lead chromate and from licking labels colored with the same substances. Women in industrial districts occasionally suffer from washing clothes impregnated with lead. Used medicinally, either internally or as topical applications, lead has exceptionally caused toxic symptoms.

Pathology.—Anatomically, the most important changes are found in the peripheral nerves, similar to those occurring in many other toxic conditions. The motor endings in the muscles show parenchymatous neuritis, evidenced by segmentation of the myelin and breaking up of the axis cylinders. In the nerve trunks patches of degeneration occur, but the changes are always more marked toward the periphery, and gradually diminish on passing up toward the cord. In a few cases atrophy of the cells of the anterior cornua and of the anterior nerve roots have been found, but these are slight and inconstant. The rapid loss of power in the affected muscles, followed by wasting and associated with the reaction of degeneration, corresponds with the usual anatomical changes, whilst the occasional occurrence of gradual loss of power and electrical irritability and slow wasting of the muscles suggest an origin in the anterior cornua in such cases. The muscles undergo atrophy, owing to the degeneration of the nerve fibres. There

[1] Oliver "Lead-poisoning," *Brit. Med. Journ.*, 1891, i.

is no evidence that lead exerts any primary influence on them. No constant anatomical changes occur in cases of lead encephalopathy, and the symptoms may be referred to the toxic agency of the metal. The vessels of the brain are commonly affected by arterio-sclerotic changes, which in turn may lead to areas of softening or hemorrhage.

Lead is found in the various organs—the liver, kidneys, brain, and bone marrow. The kidneys are frequently attacked by interstitial nephritis, usually associated with general arterial sclerosis. According to Oliver, the liver cells undergo degeneration, and there is an intercellular infiltration of round cells similar to that seen in congenital syphilis. Experimentally, parenchymatous changes in the kidney result from lead and precede interstitial nephritis, and it seems probable that parenchymatous changes also occur early in man.

Symptoms.—Individuals suffering from lead-poisoning usually present an earthy, sallow tinge of skin and a moderate grade of anæmia. The general nutrition is commonly impaired. Loss of flesh, weakness, tired sensations, severe pains in the joints, and headache often occur.

Of all the symptoms, the *lead line* on the gums is by far the most valuable as a diagnostic sign. The line is present in the gum just at the line of junction with the teeth on both upper and lower jaws, but usually better marked on the former. Of a deep blue, sometimes almost black color, it is usually readily observed. At times it is very faint, and a careful inspection is required for its detection, as it may be present opposite only one or two teeth. Exceptionally a lens is required, the line being represented by a few dots on the prominent part of the gum between the teeth. In a few cases it is completely absent, particularly when the teeth are kept clean and free from tartar. Patches of a slaty color, although rare, may spread over the surface of the gum, and even occur on the tongue, cheeks, and the inner surfaces of the lips. The lead line is due to the deposit of lead sulphide in the papillæ of the gums, and is formed by the combination of lead circulating in the blood with sulphuretted hydrogen generated by decomposition of tartar on the teeth. The line is at times seen in individuals presenting no other evidence of plumbism. It has been developed in twenty-four hours from the medicinal use of lead, and is occasionally produced when absent by the administration of iodide of potassium, which frees the metal from its combinations in the tissues. Once present, the line persists for a considerable period, seldom disappearing when well marked for at least three months, and often continuing for a much longer period. The gums are frequently spongy and swollen and the tongue is coated; there is a metallic taste and the breath is fetid.

Anæmia, which is so constantly present, usually reaches a moderate grade only. The red blood-corpuscles seldom fall below 3,000,000, whilst hæmoglobin is usually diminished to a much greater degree than the corpuscles. Anæmia is one of the earliest symptoms of acute lead-poisoning. At times the blood deteriorates rapidly and a considerable grade of anæmia may be reached in a few weeks. In a case recently under observation a man, after a few weeks' exposure to white lead, developed a marked grade of anæmia with optic atrophy. The red blood-corpuscles sank to 2,400,000 and the hæmoglobin to 20 per cent.

Microscopically, poikilocytosis is observed in the severer cases, and nucleated red cells have been described.

Gastro-intestinal Symptoms.—Lead colic is one of the most frequent and earliest manifestations of lead-poisoning. It was long known in the south of England as "Devonshire colic," resulting from the use of cider impregnated with lead. It has been very common in the French navy from the use of water contained in lead cisterns, and under the expressive name of "dry bellyache" it has frequently occurred in the West Indies. In its most characteristic form there are violent paroxysms of abdominal pain, sometimes beginning suddenly, or again preceded by pains of moderate severity for some days or weeks. The violence of the pain at times produces great restlessness and mental excitement. The pain is doubtless due to spasmodic contraction of the intestine, and Tanquerel states that he has felt spasmodic contraction of the rectum on digital examination.

Rectal and vesical tenesmus sometimes occurs, or there may be strangury and retention of urine. Obstinate constipation is usually associated with colic, and in a few cases diarrhœa. Severe vomiting and retching are often present, the vomited material being usually tinged with bile.

Rigidity and retraction of the abdominal muscles are commonly well pronounced, and the abdomen is sunken and boat-shaped. Fulness and distention are seen only in a minority of cases. Pressure almost invariably gives a certain degree of relief to the pain, very seldom increasing it.

During an attack of colic the pulse becomes hard and incompressible. Sphygmographic tracings show the characters of the high-tension pulse. Borgen,[1] working with V. Basch's sphygmomanometer, has shown that the arterial pressure remains high for from one to four days, corresponding with the period of colic, and then during the next two to four days falls to normal or subnormal. The pulse rate is lessened, falling even as low as 30 or 40 to the minute. Its rate varies, but irregularity does not occur.

The respirations, especially during the attack, are often increased in number. The quantity of urine is much diminished, and contraction of one pupil may be present.

The duration of the colic seldom exceeds a week, provided no fresh exposure to lead takes place. Relapses are, however, very frequent, and are very readily induced by fresh exposure.

Paralysis.—The most common and best recognized form of lead paralysis involves the extensor muscles of the forearm, causing double wrist-drop. The paralysis is usually bilateral, although it commonly begins and is more advanced on one or other side. The onset of the paralysis is usually subacute, becoming marked in a few days up to two or three weeks.

The muscles involved are the extensor communis digitorum, the three extensors of the wrist, and the extensors of the first and second phalanges of the thumb. The supinator longus and the extensor indicis and metacarpi pollicis commonly escape—a point which serves to distinguish this affection from paralysis of the musculo-spiral nerve. The

[1] Borgen: *Deut. Arch. klin. Med.*, 56, p. 248.

paralyzed muscles gradually atrophy, and the hollow on the back of the forearm forms a marked contrast to the prominence of the supinator longus. Owing to the loss of support of the extensors, the grasp is weak and there is an apparent, but not a real, loss of power in the flexors of the forearm. The back of the hand in old-standing cases becomes prominent from backward displacement of the carpal bones, and also probably by slight distention of the synovial sacs.

Although lead paralysis is usually limited to the muscles above mentioned, yet other groups of muscles may be attacked, either primarily or secondarily to them. The muscles of the upper arm occasionally suffer. The deltoid is most frequently attacked, and later the biceps, brachialis, anticus, supinator longus, the spinati, and rarely the triceps and pectoral muscles. Marked atrophy of the small muscles of the hand (Duchenne-Aran type) is not very infrequent. The thenar and hypothenar eminences waste, and if the affection begins here, it closely resembles progressive muscular atrophy.

In the legs paralysis is rare. According to Tanquerel,[1] it was present in 15 of 102 cases, and in 10 of these 15 the arms were also affected. The group of muscles most commonly affected are the peronei and the extensores communes digitorum and halluces (peroneal type). These muscles, it is interesting to note, are the homologues of the extensors of the forearms. The tibialis anticus, which is homologous with the supinator longus, usually escapes. In children, however, paralysis of the legs, as shown by Putnam, occurs first.

The cranial nerves are very rarely affected. Mackenzie has described paralysis of the adductors of the larynx, and Buzzard[2] a case of complete paralysis of the third nerve, including the pupil. It is more common, however, to find strabismus resulting from paralysis of an isolated ocular muscle.

Ataxia of the lower extremities, as in other forms of peripheral neuritis, has been observed in a few cases. Walton has published a case in which this symptom was the principal one present.

Gowers[3] has pointed out that paralysis may be primarily atrophic or degenerative, a distinction of much importance in prognosis. The atrophic form is the commoner, and is well exemplified in the ordinary wrist-drop. The muscular weakness precedes the atrophy, and the electrical reactions resemble those noted in lesions of the peripheral nerves. Muscular weakness may occur without going on to atrophy, and is frequently noted in the muscles of the arm, less commonly in the thigh. Here qualitative and quantitative changes may be noted with the voltaic current. In these cases depending on nerve degeneration recovery usually is complete.

In the degenerative form the weakness proceeds simultaneously with and is proportional to the wasting. It occurs most frequently in the small muscles of the hand. The faradic and voltaic irritability of the muscles is diminished in proportion to the wasting. This form resembles progressive muscular atrophy in the locality of the muscles first affected, in their electrical reactions, in the presence of fibrillary twitchings, and also in the fact that the paralysis is frequently permanent.

[1] Tanquerel des Planches on *Lead Diseases*, trans. by Dana.
[2] Buzzard: *Brain*, 1890.
[3] Gowers: *Diseases of the Nervous System.*

The sphincters of the bladder and rectum are attacked in only exceptional instances.

Muscular tremor occurs in a certain proportion of cases, but is not nearly so common as in mercurial poisoning. It may be either fine or coarse, and is usually increased by movement. Stewart records a case in which all the characteristics of paralysis agitans were present.

A few cases are recorded in which ankle clonus and increase of the knee jerks have been present, but no changes to account for this condition have yet been observed in the lateral columns of the cord. In one such case treated by the writer there was general muscular weakness without any localized paralysis or atrophy.

There is a rare form of general muscular paralysis due to lead, coming on rapidly and involving the muscles of the limbs, trunk, abdomen, thorax, and larynx. The muscles of the neck, however, escape. Recovery is the rule, and when improvement takes place it is usually rapid. Death, however, may occur from paralysis of the diaphragm and other respiratory muscles, as in Landry's paralysis.

Sensory Symptoms.—Defects of sensation are slight and not very common. There may be numbness and diminished tactile sensation over the inner or posterior part of the forearm in wrist-drop and also in the legs. Hyperæsthesia has also been noted and referred to neuritis.

Subjectively, pains in the joints and muscles are very common. The former are frequently referred to as "saturnine arthralgia," and may be of a dull or sharp character. Tenderness in the muscles, probably referable to involvement of the intramuscular nerve twigs, and muscular cramps in the calves are not uncommon. Tenderness of the nerve trunks is sometimes met with.

Lead Encephalopathy.—Cerebral symptoms are among the rarer manifestations of lead. Occurring almost exclusively among workers in lead who have been intensely poisoned, yet the occasional development of encephalopathy from accidental poisoning must not be overlooked. Stewart has reported a number of cases from eating buns colored with lead chromate.

Convulsions, delirium, and coma are the most striking features of lead encephalopathy. The time at which cerebral symptoms develop after exposure varies within wide limits. In the majority of cases the symptoms come on within a year. In Tanquerel's table of 72 cases the shortest period was eight days and the longest fifty-two years after exposure. In cases where there has been prolonged exposure a history of colic, paralysis, or arthralgia is usually obtainable. Premonitory symptoms are seldom wanting. An earthy tinge of the skin, anæmia, and cachexia are usually present, and violent headache with vomiting frequently precedes the attack. Vertigo, disturbance of vision, insomnia, tremor, restlessness, mental depression, irritability of temper, and even hallucinations and delusions, have been observed before the outbreak of severe cerebral symptoms. Of these, convulsions are the most common manifestations, and resemble epileptic seizures in the character of the spasms. In severe cases they may recur with great frequency, and are accompanied by coma in the intervals, and are then of the gravest possible omen. Cheyne-Stokes respiration, œdema of the lungs, and high temperature may precede the fatal issue. Stewart

reports 2 cases in children in which repeated convulsions proved fatal in eight and twelve hours respectively.

In exceptional cases the attack may assume the characters of hystero-epilepsy, sometimes with hemianæsthesia or even catalepsy, and, occurring in young girls, prove very misleading. In rare cases the tendency to convulsions continues, and a condition of chronic epilepsy ensues.

Delirium is less common than convulsions, with which, however, it may be associated, and extends over a period of days or weeks. It is frequently of an active, noisy character and the patient may require restraint. When associated with tremor it bears a close resemblance to delirium tremens. Coma may also occur alone, although usually associated with convulsions or delirium.

In all these conditions the lead line on the gums proves an important clue to the cause of the symptoms, and in all obscure cases with cerebral symptoms it is well to bear in mind the possibility of lead-poisoning.

In the presence of nephritis in lead-poisoning it may be difficult or impossible to say whether the symptoms are uræmic or due to the toxic action of lead—a problem which is still further obscured by the fact that the urine is frequently voided in bed.

The increased patellar reflex commonly present in lead encephalopathy has no diagnostic value.

Neuro-retinitis is common in cases of acute lead-poisoning, and especially so in lead encephalopathy. The disk is swollen, its edges are blurred, and small hemorrhages are sometimes present in the retina. In the less severe cases vision may return, but in the severer ones it is only too apt to go on to consecutive atrophy. Primary optic atrophy may also occur, and ultimately advance to complete blindness. Occasionally temporary amaurosis is observed, resembling that occurring in uræmia in being unassociated with ophthalmoscopic changes. Annular scotomata and concentric limitation of the visual field and loss of color vision have been described. The latter two symptoms have been found associated with hemianæsthesia—a fact which is suggestive of an hysterical origin.

The various changes referred to may be present in the absence of renal disease.

Sexual Functions.—Lead has a striking influence on the sexual functions. Young women develop amenorrhœa or menorrhagia. Pregnant women are extremely liable to abort, and the same result is common when the father only is the subject of plumbism. The children of parents affected by lead commonly develop convulsions, which are frequently fatal during the first few months of life. As with alcohol, there is a marked predisposition on the part of such children to various neuroses. Ankel records a case of direct heredity of lead-poisoning, but it is inconclusive.

COMPLICATIONS.—*Cardio-vascular and Renal Disease.*—Arterio-sclerosis is found in a large proportion of old-standing cases of lead-poisoning. The arterial pressure, which is raised intermittently during the attacks of colic, becomes constantly higher, as evidenced by the hard, incompressible pulse, and the arteries gradually become thickened. Associated with the increased pressure the heart hypertrophies and the

second sound becomes loud and ringing. The kidneys are also involved, lead being a well-recognized cause of interstitial nephritis. The urine in such cases has the usual characters seen in interstitial nephritis, being abundant, pale, of low specific gravity, with a small or moderate amount of albumin and few casts. Albuminuria may occur as a temporary symptom, especially during attacks of colic.

Lead can be detected in the urine by chemical analysis, but it is questionable whether small traces of the metal have much significance as a diagnostic sign, as the metal has been found repeatedly without signs of poisoning. In doubtful cases, however, the finding of moderate quantities of lead may clear up an obscure case. It is well to give a few doses of iodide of potash before examining, so as to increase the excretion of the metal.

Gout.—Gout as a complication of lead-poisoning was first observed by Garrod, and London physicians have found gout present in 25 to 30 per cent. of cases. In the north of England and America the association of these affections is rare. According to Luethje, gout resulting from lead differs from other forms in more frequent recurrences of the attacks, in a shorter course, and in the tendency for joints, such as the knee, hip, and vertebræ, which are rarely or never affected in the usual form, to become involved. Gout resulting from lead often commences earlier in life than when due to other causes; thus in 107 cases collected by Lorimer gout occurred before the age of thirty-five in 70.

Diagnosis.—In most cases the recognition of lead-poisoning is easy. The presence of such characteristic symptoms as wrist-drop or colic, associated with the blue line on the gums, is unmistakable.

The lead line is absent only when the gums are perfect and where scrupulous cleanliness of the mouth has been observed. Should the line prove absent, with spongy gums or the presence of much tartar on the teeth, we can usually exclude lead-poisoning. In the absence of a lead line it is necessary to prove the ingestion of lead or its excretion in the urine. To this end careful inquiry into the occupation and environment of the patient, a chemical analysis of the drinking water or of the urine after the administration of a few doses of iodide of potassium, may prove necessary. Dixon Mann has pointed out that the excretion of lead is sometimes absent for a day, so that the analysis should be repeated in a suspected case.

The cases which are most apt to be overlooked are those in which the symptoms are anomalous. Paralysis commencing in an unusual situation or the sudden supervention of cerebral symptoms may throw the practitioner off his guard, and the possibility of the symptoms being due to lead be entirely overlooked. Symptoms of lead-poisoning occurring in other members of the family may form the only clue in some obscure cases.

Prognosis.—The prognosis depends largely on the ability of the patient to give up the work in which he has been poisoned. Fresh exposure is almost certain to lead to a recurrence of the disease, often in an aggravated form.

Recovery from the usual forms of paralysis takes place in a few months, although in severe cases a year, or even two years, may elapse

before recovery occurs. Some cases, however, are permanent, especially the degenerative form (Gowers).

Cerebral symptoms are serious where convulsions are frequent or where they have been preceded by delirium. Cardio-vascular and renal complications are of course permanent and progressive even where the toxic influence is removed.

Treatment.—The treatment consists, primarily, in the removal of the patient from the toxic influence; secondly, in eliminating the metal from the tissues; and thirdly, in combating its effects.

In fulfilling the first condition scrupulous cleanliness must be insisted on, and poisoning may often be prevented by attention to hygienic rules. The workman should wash his hands before eating, so as to remove all particles of lead and prevent their ingestion with the food. A few drops of sulphuric acid in water has long had a reputation as a preventive, or the same effect may be produced by a small daily dose of magnesium sulphate. In both cases an insoluble sulphate is formed.

Elimination of lead takes place chiefly by the urine and fæces. An occasional purgative, especially sulphate of magnesium, may be administered in the morning. Iodide of potassium is universally admitted to be a remedy of much value, but its mode of action is obscure. Careful analyses by Mann showed that the quantity of lead excreted by the urine is not increased with the use of this drug, but there is no doubt that marked benefit often results from its use. The dose should not exceed thirty grains daily, and commonly fifteen grains suffice. With severe cerebral symptoms it is usual to omit the drug, owing to the generally accepted view that the metal is freed from its combination in the tissues and may thus aggravate the symptoms.

In the treatment of symptoms colic requires the administration of opium or morphine. This drug not only relieves pain, but also relaxes the intestinal spasm on which it depends. It thus proves a valuable adjuvant to purgatives required to relieve constipation. One quarter or one half grain of morphine may be administered hypodermically or fifteen to twenty minims of Batley. If constipation is obstinate, a large enema of soap and water or turpentine ʒj to the pint may be required in addition to the morphine and purgatives. Atropine is also of value, combined with morphine, in relaxing intestinal spasm and relieving constipation. For the paralysis strychnine is commonly administered, although the benefit it produces is difficult to estimate.

Galvanism is of much value in keeping up the nutrition of the paralyzed muscles, but faradism, producing no contraction, is useless. For the anæmia iron is useful, and it may be combined with iodide of potassium.

CHRONIC MERCURY-POISONING.

Owing to improved hygienic conditions among work-people chronic mercurial poisoning has now become a rare disease. In England it was formerly often seen among gilders, who used charcoal fires to vaporize

the metal. In quicksilver-mines, where the ore is heated, symptoms are very apt to appear, and numerous instances are reported from the workers at Almaden in Spain. The metal volatilizes, however, at ordinary temperatures, so that the disease may show itself even in those who handle it. Mirror-gilders, thermometer and barometer makers occasionally suffer, as do also hatters and furriers, who use mercurial salts in the preparation of pelts and skins.

When used medicinally it is common to see stomatitis, and acute poisoning has repeatedly occurred from vaginal douches of sublimate during the puerperium. Leyden[1] and others have recently described cases of multiple peripheral neuritis from the use of mercurial inunctions.

As with lead, there is a marked personal predisposition, certain individuals being very easily affected by the metal or its salts. Naunyn quotes a case in which a girl was affected with stomatitis through rooming with her sister, who was engaged in silvering mirrors and who remained free herself. Most practitioners have seen cases in which even small doses of calomel will produce stomatitis. Severe and even fatal cases of stomatitis with necrosis of the jaw are recorded from the use of doses of from five to fifteen grains of calomel. Symptoms frequently do not show for many years after exposure. At the Almaden mines it is stated that most of the sufferers from nervous symptoms are over middle life, although they commence work at the age of nine or ten. Symptoms of stomatitis or gastro-intestinal derangement may, however, show shortly after exposure.

Pathology.—In acute cases of sublimate-poisoning an intense diphtheritic inflammation of the intestines is produced, even when the poison is absorbed from other mucous surfaces. Acute parenchymatous nephritis also occurs in these cases. Experimentally lesions have been described by Letulle in the peripheral nerves,[2] consisting in degeneration of the medullary sheath, the axes cylinders being intact. Myelitis has also been produced experimentally.

In man anatomical details are lacking, but the generalized tremor, the paralysis without muscular atrophy, the unaltered electrical reactions, and the retention of the knee jerks, are suggestive of a cerebral rather than of a spinal or peripheral origin. There is, however, clinical evidence that the peripheral nerves may suffer as well, and this is in accord with what we know of such metallic poisons as lead and arsenic.

Symptoms.—In cases of chronic mercurial poisoning the symptoms are chiefly on the side of the nervous system. Stomatitis may be absent, especially in chronic cases. When present it is first evidenced by a peculiar fetor of the breath; the gums become swollen and bleed easily; the teeth loosen in their sockets; the tongue is heavily coated; and there is a marked increase of the salivary secretion. Ulcers covered with grayish sloughs are frequently seen on the mucous membrane of the cheeks or lips, and in severe cases necrosis of the jaw may occur. The patients are generally weak and present a considerable grade of anæmia; the skin in old-standing cases has a peculiar brownish tinge; the hair falls out and the nails become brittle.

[1] Leyden: "Polyneuritis Mercurialis," *Deut. med. Woch.*, Dec., 1894; Gilbert: "Pseudo-tabes Mercurialis," *ibid.*, 1893. [2] *Arch. de Physiologie*, 1887.

The most characteristic symptom is tremor, commonly known among the work-people as "the trembles." In the early stages of the disease it is present only on movement or with mental excitement. Eventually, however, it becomes more or less constant, but it is only in exceptional and severe cases that it continues with lessened intensity during sleep. Tremor is first noticed in the face and tongue, later spreading to the limbs. It interferes greatly with articulation, causing hesitation and stammering in speech. Letulle records two cases where the eyes were affected by the arrhythmical nystagmus.

Weakness of the limbs usually ensues, most commonly of the forearms, although the legs are occasionally involved. The loss of power may be limited to a single limb. Accompanying the weakness there are frequent areas of diminished sensation on the limbs, and even on the trunk, attributed by Letulle to degeneration of the peripheral nerves. There is, however, no atrophy of the muscles, the faradic and galvanic irritability of the nerves remains normal, and the knee jerks are preserved. The functions of the bladder and rectum remain normal. Leyden has recorded a case of multiple peripheral neuritis marked by ataxia, pains and weakness in the limbs, and loss of knee jerks, which he attributes to the use of mercurial inunctions in syphilis.

A peculiar train of psychical symptoms is sometimes seen in chronic mercurial poisoning, known as mercurial erythism, and they may either precede or follow tremor. This condition is characterized by irritability, mental excitement, and difficulty in fixing the attention on any subject. There are sleeplessness, headache, and sometimes distressing hallucinations, with outbreaks of insanity. Sensory symptoms are common in the form of violent neuralgic pains, especially along the course of the fifth nerve and in the joints. Like lead, mercury occasionally produces hysterical manifestations such as hemianæsthesia or paralysis. Paroxysms of dyspnœa resembling asthma and palpitation of the heart occasionally occur. The appetite is usually preserved, although intestinal disturbance in the form of diarrhœa is occasionally seen, as are also melæna and hæmatemesis. Temporary albuminuria, and even nephritis, are not infrequent, and dropsy resulting from cachexia may occur apart from albuminuria. Abortion occasionally results, and the children of parents suffering from the disease are often delicate and readily develop rickets or tuberculosis. According to Naunyn, tuberculosis is a frequent cause of death.

Diagnosis.—Evidence of absorption of mercury renders the diagnosis easy. A history of stomatitis or of previous attacks of tremor is also suggestive in a doubtful case. Some stress has been laid on the condition of the teeth as a diagnostic sign. In old-standing cases they become dark colored or black, and their surface is traversed by numerous horizontal and vertical lines, giving them an appearance as if corroded by an acid. In obscure cases an analysis of the urine should be made for mercury. The tremor of paralysis agitans, of disseminated sclerosis, and of general paralysis of the insane may simulate mercurial tremor, but other signs of these diseases are seldom wanting, and suffice to make the diagnosis clear.

Prognosis.—Recovery usually occurs if the patient is removed from the noxious influence of the metal. Tremor or weakness may, however,

be permanent, and severe neuralgic pains may persist after the motor symptoms have ceased.

Treatment.—The first essential in treatment is to remove the patient from the influence of the metal. It is important that a nourishing diet should be administered to combat the weakness and anæmia so commonly present. Iron and cod-liver oil are also valuable in this relation. Iodide of potassium is used as an eliminative. It should be given in doses of five to fifteen grains daily in divided doses, as larger doses have repeatedly produced stomatitis or increase of tremor from too rapid elimination.

Treatment by the use of warm baths has long been in vogue, and, as there is evidence that the metal is eliminated by the sweat, the practice rests on a rational basis. For the tremor and paralysis electricity has been recommended, but is of doubtful efficacy. Antiseptic mouth-washes are required if stomatitis is present.

CHRONIC ARSENIC-POISONING.

The commonest source of poisoning is wall-paper colored with arsenic. It has been shown that certain moulds have the power of liberating arsenic in a volatile form. This action is favored by moisture—a fact which corresponds with the observation that poisoning from this source is most frequent in damp weather. Arsenic is often present in the coloring matter of artificial flowers and fruits, carpets, certain dress goods, curtains and hangings, turkey-red cotton, red striped bed-ticking, the paper of tobacco wrappings, playing cards, labels, and the paper used in kindergartens ; and these articles are all recorded as having proved a source of poisoning. Stuffed animals or birds are often treated with arsenic and have produced toxic symptoms. It is an open question whether Paris green, so freely used by market-gardeners, is found in fruits or vegetables. From the medicinal use of arsenic it is common to see minor toxic effects, and a considerable number of cases have been recorded of late years of general peripheral neuritis from this cause.

Toxic symptoms, especially neuritis, may occur after a period of some days or even weeks have elapsed after the ingestion of arsenic. Numerous instances are recorded where paralysis appeared from a single poisonous dose after the irritant gastro-intestinal symptoms had disappeared.

Pathological Anatomy.—In chronic poisoning the peripheral nerves undergo extensive parenchymatous degeneration similar to that found in lead. Atrophy of the cells of the anterior cornua has also been observed in man, and in animals Schaffer has constantly found degenerative changes in the cord. Walkow experimentally has found fatty metamorphosis in the liver cells, also patches of necrosis and intercellular infiltration of leucocytes.

Symptoms.—Chronic arsenical poisoning manifests itself by catarrhal, gastro-intestinal, cutaneous, and nervous symptoms. Of these, the nervous symptoms are the most prominent and important ; they

occur associated with or apart from other manifestations, and are remarkable in often appearing after the administration of arsenic has ceased. An interval of a few days up to three or four weeks may elapse between the taking of arsenic and the appearance of symptoms.

The essential features are due to extensive peripheral neuritis, closely resembling that due to alcohol, and differing from lead neuritis in usually commencing in the legs and in the prominence of sensory symptoms. At the outset sensory symptoms are prominent, commencing in the extremities of the affected limbs. They consist in paræsthesia, such as numbness and tingling, hyperæsthesia, severe pains, marked tenderness of the nerves and muscles, and later anæsthesia. Motor symptoms are manifested either in the form of paralysis[1] or of ataxia, the so-called pseudo-tabes,[2] and these symptoms are often combined; loss of the knee jerk is an early and constant sign. The paralysis, unlike that of lead, usually begins in and is more prominent in the anterior tibial muscles. The extensors of the wrist may escape or become affected later. There is, as in alcoholic neuritis, occasional involvement of the muscles of the thighs and upper arms. The muscles undergo rapid atrophy and the wasted muscles present the reaction of degeneration.

Ataxia is often a prominent feature. It is usually associated with motor and sensory symptoms, but at times is almost pure. Contractures of the limbs ensue in old-standing cases. The cranial nerves always escape, although Gerhardt[3] has described temporary paralysis of the sixth associated with herpes zoster of the fifth.

The bladder and rectum are affected only in exceptional cases and indicate involvement of the cord.

Whilst recovery takes place in the great majority of cases, death from heart failure has occasionally been observed. Sensory symptoms sometimes persist after the paralysis has passed off, and ataxia has been observed after motor power has been regained. Cerebral symptoms, such as vertigo, impairment of the memory, and even convulsions, are stated to occur, but are certainly very uncommon.

Gastro-intestinal Symptoms.—Nausea, vomiting, and abdominal pain may be present for a considerable period without their true nature being suspected. The tongue has sometimes a silvery aspect, and Putnam refers to several cases in which salivation with swelling of the submaxillary and lingual glands were prominent features. In other cases catarrhal symptoms in the nose, larynx, and bronchi, and even hæmoptyses, are present, and a moderate grade of fever is sometimes observed.

Locally, arsenic is a cutaneous irritant, but even when taken internally various forms of eruption have been noticed. Urticaria is the most common, but an erysipelatous inflammation of the face or a papular eruption on the face, neck, and hands has also been described.[4]

Attacks of herpes zoster are very generally admitted to occasionally occur during the medicinal administration of arsenic, and a brown pigmentation of the skin of the face, neck, and trunk is also observed under like circumstances.

[1] Dana: "Pseudo-tabes from Arsenical Poisoning," *Brain*, ix.
[2] Brouardel: "Les Paralysies arsenicales," *Arch. de Méd. exp.*, 1896.
[3] Gerhardt: *Charité Ann.*, 1894.
[4] Putnam: *Bost. Med. and Surg. Journ.*, 1889, i. p. 223.

In some cases falling of the nails and hair, anæmia, and cachexia have resulted.

Diagnosis.—Where evidence of multiple peripheral neuritis is present, not due to alcoholism, the possibility of chronic arsenical poisoning should always be considered. A history of exposure and the finding of arsenic in the urine would convert the suspicion to a certainty. It must be remembered, however, that arsenic has been found in the urine of 30 per cent. of healthy individuals in Boston, so that this test cannot be regarded as conclusive.[1]

Gastro-intestinal or catarrhal symptoms, especially when they occur alone, are frequently misinterpreted, and it may only be when several members of a family are attacked that a toxic cause is suspected.

Prognosis.—The great majority of cases of paralysis recover, but often only after an illness of many months.

Treatment.—The treatment does not differ essentially from that of lead. If due to wall-paper, this should be completely removed and not merely covered with fresh paper. Iodide of potassium has the same action in elimination as in poisoning with lead or mercury.

The treatment of neuritis is similar to that of neuritis from other causes.

CHRONIC SILVER-POISONING; ARGYRIA.

Chronic poisoning by silver is of rare occurrence. It has most frequently resulted from long-continued medicinal use of silver salts, which was formerly much in vogue in epilepsy. W. F. Hamilton[2] has reported two cases from v. Jaksch's clinic in workmen engaged in silvering Bohemian glass. Gowers states that symptoms appear when about an ounce of silver has been taken extending over any period of time. The metal is deposited in the tissues, where it is readily recognized in microscopic sections as small black particles. These particles are best recognized in the skin and kidney. The most striking feature is the discoloration of the skin, which becomes a deep blue color similar to that seen in intense cyanosis. The pigmentation also involves the mucous membranes, and the teeth are discolored. Gowers reports a case of double wrist-drop closely resembling lead-poisoning in an individual who for years had taken a pill containing silver. A black line was present on the gums. Parenchymatous changes are said to occur in the liver and kidneys, but little is known on this subject.

[1] Shattuck: *Ibid.*, 1893, i. p. 540. [2] Hamilton: *Montreal Med. Journ.*, xxiii.

ALCOHOLISM; MORPHINISM.

By JAMES STEWART, M. D.

ALCOHOLISM.

Synonym.—Alcoholismus.

Under this heading will be described those acute, subacute, and chronic disturbances, chiefly of a functional nature, which result from the excessive use of alcohol.

I. Acute Alcoholism.

The immediate action of alcohol in its various forms when taken in excess belongs properly to pharmacology. Under the term "Acute Alcoholism" is here understood the well-known diseases (*A*) delirium tremens and (*B*) acute alcoholic insanity.

(*A*) Delirium Tremens.

Predisposing Causes.—Delirium tremens is more prone to set in in persons who have inherited a tendency to neurotic diseases. It may be the result of a first debauch, although this is very uncommon, it usually being an incident of prolonged drinking. Traumatism and acute febrile diseases, especially pneumonia, play an important part in determining it in steady drinkers.

The disease is more common in the male than the female, in about the proportion of 5 to 1. It is highly probable that, taking an equal number of immoderate drinkers from both sexes, it will be found that males suffer more frequently than females from delirium tremens. It is a disease essentially of middle life, but may be met with in the young and those in advanced life. In the young it is usually complicated with injury or some acute febrile process. It results from the use of alcohol in all forms, being much more common, however, from spirit drinking.

Symptoms.—The onset of delirium tremens is usually characterized by a period of restlessness and anxiety lasting from a few hours to two or three days. Sleep is disturbed and there is distaste for food. Dreams of a distressing character are present during sleep. Some hallucinations of sight and hearing are present during the waking hours, and as the sleeplessness becomes pronounced the patient is never free from them. The visual hallucinations take various forms, usually of a horrible character. Rats, mice, snakes, lobsters, etc. are seen crawling about the room and over the bedclothes. Terrified in look and action, the patient

is a distressing spectacle. He imagines his attendants are conspiring to injure him, and makes attempts to get away or to attack his supposed enemies.

The visual hallucinations are constantly changing, now one form, now another, but usually of a horrible character.

Auditory hallucinations are less frequent. The patient hears the slightest normal sound greatly exaggerated; the slamming of a door may be interpreted as the sound of a house falling. He hears, perhaps, abusive or loathsome language uttered by his attendant or some imaginary person, or the words heard may be expressive of a violent altercation between several people in his room.

Perversions of taste and smell are occasionally met with. Perversions of the general sensibility are more frequent than perversions of taste and smell. The patient thinks animals of a loathsome character are crawling over his skin, into his mouth, and down his throat.

The mental state of the delirious patient is various. Usually he is constantly chattering incoherent words, in the milder cases acting out his usual occupation. When sharply spoken to he may give a rational answer. Again, he lies in a dazed condition and will not answer.

The characteristic tremor, from which the delirium derives its name, is present from early in the disease. It is most marked in the hands, face, and tongue.

Pyrexia of a greater or less degree is met with except in the mildest cases. There is rarely, except in the severest cases, a rise of temperature during the first day or two. It seldom exceeds 102° F. In the terminal stages of fatal cases hyperpyrexia may be present; temperatures of 108° or 109° have been recorded.

During the early stages the pulse is frequent, large, and easily compressible. In severe cases it becomes very frequent and small. An increasingly rapid pulse as the disease progresses is a sign of serious import. The face is usually flushed and the eyes suffused at first, but this gradually passes away and is replaced by pallor. The tongue is heavily coated, and there is complete loss of appetite. The urine will be found scanty, high colored, and often containing albumin.

Course and Termination.—The symptoms continue with unabated or increasing severity from three to six or seven days. The insomnia, which has usually been persistent from the first, gradually, or it may be suddenly, gives place to a sleep of several hours' duration, and from which the patient awakens comparatively free from delirium, and recovers rapidly. In fatal cases the sleeplessness persists, the pulse becomes more rapid and feeble, and the patient dies exhausted or he may pass into a state of coma.

Complications.—In patients who have had repeated attacks of delirium tremens we often meet with one or more of the lesions so commonly induced by the long-continued and immoderate use of alcohol, such as chronic gastro-duodenal catarrh, hepatic and renal cirrhosis, peripheral neuritis, arterial sclerosis, etc. Pneumonia is a very frequent complication. It may be, as already pointed out in speaking of the etiology of the disease, the active factor in bringing about the delirium, or it may be a secondary event, coming on during the course of the nerve disturbance. It is all important to remember

that the symptoms of pneumonia occurring as a complication of delirium tremens may be masked by the intensity of the latter. It is therefore a good routine practice to make a careful physical examination of the chest repeatedly throughout the course of the disease.

Diagnosis.—The clinical features of delirium tremens are so striking that it can be but very rarely mistaken for any other disease. The special-sense hallucinations, the tremor, and the history of alcoholism are usually so apparent that a certain diagnosis is easily arrived at. When pyrexia is marked at first, it presents some resemblance to meningitis, but in the latter headache and vomiting are striking features of the onset, while these symptoms are not met with in delirium tremens.

Prognosis.—Recovery is the rule in the great majority of first attacks, provided that there are no complications, such as pneumonia. In repeated attacks, especially in those with degenerated kidneys, sclerosed arteries, or fatty hearts, the prognosis is always serious. Delirium tremens occurring as the result of a severe traumatism frequently proves fatal. The older the patient the greater the danger. Considerable elevation of temperature (103° to 104° F.) is a grave symptom. Hyperpyrexia is rarely recovered from. Persistent insomnia is also an unfavorable symptom; the same is true of a rapid and weak pulse. The mortality varies greatly, being much greater in hospital than private practice in the proportion of perhaps 10 to 1.

Treatment.—1. *General Management.*—The patient should be kept in bed and constantly watched. There is always danger that he will make attempts to escape, and to prevent this sufficient attendance should be at hand. If this is not procurable, he should be restrained by a sheet drawn across the trunk and firmly secured at the sides of the bed; the arms and legs may be effectually secured by sheets also. In very violent cases this comparatively mild physical restraint induces less exhaustion than the efforts necessary where the patient is forcibly kept in bed by the efforts of the attendants. The method carried out in the Hamburg General Hospital, of keeping the patient in a brilliantly illuminated (electric) room, appears to work well. It is considered that it is better than confinement in a dark room.

The diet should be very carefully attended to. It is a matter of great importance to feed the patient well from the beginning. If he refuses food or if he rejects it, it should be given by the rectum in the form of peptonized milk and gruel. The diet should be liquid; milk and animal broths are the best. It is advisable to give moderate quantities of either at short intervals.

The state of the pulse is the indication for the use or otherwise of stimulants. In the majority of cases stimulants are not only unnecessary, but distinctly injurious. In repeated attacks in advanced life it would be well to give them, especially if there is a tendency for the pulse to become frequent and small. Alcohol in such cases can be combined with capsicum with advantage. Coffee may be used also for its stimulating action.

Medicinal Treatment.—The medicinal treatment of delirum tremens is of much less importance than the dietetic. The custom of employing hypnotics in large doses and early in the disease is one fraught with danger, and is rarely productive of any good. When the disease tends

to terminate, then the action of a hypnotic may be sufficient to turn the scales in favor of sleep. The usually employed hypnotics in this disease include opium, morphine, chloral, chloralamide, sulphonal, trional, tetronal, hyoscine, hyoscyamine, bromides, and Indian hemp. All of these agents should be used only in moderate doses, as all may have untoward effects if given in too large doses or too frequently repeated. There is no doubt that there is a great insusceptibility to the action of narcotics and hypnotics in the earlier days of an attack, and if the dose is increased to bring about sleep, we may induce a fatal narcotism. There can, I think, be but little doubt that chloral hydrate is, of all drugs, one of the most dangerous to use in delirium tremens. I refer to its use especially in quantities exceeding twenty-five or thirty grains. In old drunkards with fatty hearts the sleep induced by quantities of sixty grains and upward may be the final sleep.

Opium and sulphonal, although not entirely free from objections, are less liable than any of the other agents mentioned to prove injurious. The dose of morphine should not at first exceed the one sixth of a grain hypodermically.

Sulphonal in twenty-grain doses, given in hot coffee, is fairly trustworthy if given when there are signs of abatement of the nerve disturbance.

A combination of bromide of potassium with Indian hemp throughout the whole course of the disease is at least not likely to be harmful. It will tend to abate the motor restlessness. When this is extreme the cautious employment of either hyoscine or hyoscyamine is to be recommended. The initial dose of either of these alkaloids should not exceed the one two hundredth of a grain hypodermically.

Attempts in some quarters have recently been made to reintroduce into practice a custom formerly much in vogue—the treatment of delirium tremens by large doses of digitalis. Such practice is not only very unscientific and useless, but positively dangerous.

(*B*) Acute Alcoholic Insanity.

Synonyms.—Acute alcoholic delirium; Mania à potu.

Acute mania may supervene where there is predisposition to insanity after a bout of drinking, the alcohol in such cases being the exciting cause. Acute mania of alcoholic origin is seldom met with except in periodical drinkers. It is commonly ushered in with great suddenness, the subject passing into this state after a few days' or hours' drinking. It is characterized by sudden and extreme violence, lasting, it may be, only a few hours or with intermissions for a few days. It differs from delirium tremens in the absence of tremor and restlessness, and by the presence of more marked delusions and ungovernable fury. The disease runs a shorter course than ordinary acute mania.

Prognosis.—Alcohol may induce an acute melancholia as well as an acute mania. In both states the prognosis is favorable.

Treatment.—The principles of treatment are the same as those of delirium tremens—frequent feeding with concentrated liquid nourishment and the employment of hypnotics. Hyoscin or hyoscyamine hypodermically is likely to be of more value than the other calmatives

mentioned. Cold bathing may also prove to be an effective measure in some cases.

Chronic Alcoholism.

Under the term "Chronic Alcoholism" will be described the various somatic and mental symptoms induced by the long-continued use of alcohol in its various forms.

The chronic effects of alcohol will be considered under the following heads:

1. On the gastro-intestinal tract;
2. On the liver and kidneys;
3. On the respiratory system;
4. On the circulatory system;
5. On the integumentary system and visible mucous membranes;
6. On the central and peripheral nervous system.

1. *The Morbid Changes and Symptoms induced by the Long-continued Use of Alcohol in the Gastro-intestinal Tract.*—One of the most common effects of the prolonged effects of alcohol is chronic pharyngeal and gastro-intestinal catarrh. The tongue is furred or glazed and red. The appetite for the morning meal is poor till the patient takes his accustomed dose. There is usually constipation, at times alternating with diarrhœa.

2. *Changes in the Liver and Kidneys.*—Alcohol induces changes of an interstitial character in the liver, leading to the well-known "gin-drinker's liver." The result may be either an atrophic or hypertrophic cirrhosis.

In the kidneys interstitial changes are also met with, due to either the direct action of the alcohol or indirectly through the degenerative changes induced in the arteries. The kidneys are found increased in size irrespective of any further changes.

3. *Action on the Respiratory System.*—The breath is peculiarly heavy and has an unmistakable odor. The respirations are often quickened as the result of degenerative changes in the heart. There is no doubt that, owing to the lessening of the general resistive power, there is a greater tendency to the development of pulmonary tuberculosis than in a healthy state.

4. *Action on the Circulatory System.*—Alcohol is a prolific cause of degenerative changes in the arteries and myocardium. Beer-drinking tends to bring about arterio-sclerosis more rapidly than other forms of alcohol, chiefly through overloading the vessels, but there is in addition a direct degenerative change which affects both the arteries and the heart. These morbid changes react on each other, and do eventually lead to the grave group of symptoms due to loss of cardiac compensation.

5. *Action on the Skin and Visible Mucous Membranes.*—Usually the confirmed toper presents a characteristic facies. There is dilatation of the pupils and hyperæmia of the conjunctival mucous membrane. The eyes are watery. The small veins of the nose and cheek are dilated. There may be acne rosacea.

6. *The Action on the Central and Peripheral Nervous System.*—The long-continued use of alcohol induces numerous nerve symptoms due

to either functional or organic disturbance, the most common symptom being a fine tremor, only noticeable on movement and chiefly seen in the hands and tongue. It is often felt at the wrist in examining the pulse when not elsewhere particularly noticeable. The tremor is greatest in the morning, and usually disappears when several "drams" have been taken. Irritability of temper is a marked feature. Loss of memory and a general inability to attend to the usual work are very frequent manifestations of chronic alcoholic poisoning.

The sleep is often disturbed with distressing dreams, and hallucinations may bring about a condition on the borderland of delirium tremens. There is a general enfeeblement of all the higher functions. It is noticed among the first symptoms that the subject has lost consideration for the feeling of others. He is more selfish and less charitable. He loses taste and capacity for work of all kinds. He is careless about his person. His whole moral nature has undergone a profound change. From this condition there is only a step to actual insanity. The insanity of chronic alcoholism in some of its symptoms does not differ from delusional insanity brought about by other causes, while in other respects there is a sharp contrast.

Bevan Lewis says "that perhaps too much emphasis has been laid on the sensory and mental disturbances of chronic alcoholism to the exclusion of the motorial in the diagnostic indications usually appealed to; for, certainly, the motor group are the 'telltale' symptoms which most clearly indicate the agencies which have been at work."[1]

In a valuable paper on the lesions induced by alcohol on the cortical nerve cell, Berkley of Baltimore says:[2] "First come the sensory disorders—the exaggeration of the sensibility of the skin, the anæsthetic symptoms, the ocular and auditory troubles; then follow the tremor, the tremulous articulation, the loss of tone in the muscular system, the tottering gait, the occasional paretic attacks, the inco-ordination; and, lastly, the intellectual disorders, the loss of moral force, the weakening of the mental faculties, the falsification of the judgment, the slowness of memory, and, finally, the dementia, which is seldom complete. The first of these periods would correspond to the beginning of the vascular troubles, when the nerve cells, irritated by the presence of a poisonous stimulus and an insufficient supply of proper nourishment, overact for the time, and then, as nutriment is still withheld from them, altered metabolism results.

"The beginning swelling of the dendrites of the sensori-motor region is marked by anæsthetic and paræsthetic symptoms; those of the purer sensory regions by visual and ocular troubles and some amnesia, especially for recent events; or, in other words, cells that have the function of evolving thought cannot work properly, and defective memory results. Later, as the motor cells become more and more involved and nuclear changes begin, continuous tremor becomes apparent; the muscles no longer co-ordinate perfectly, unless for a moment under the direct influence of the will; still later, when a portion of the cell structures becomes highly degenerated and the altered cells have become more numerous, the already tottering will-power becomes less and less active,

[1] *Text-Book of Mental Diseases*, p. 323. [2] *Brain*, No. 72, 1895.

judgment and memory fail, and when the degenerative process has far advanced an incomplete dementia is the final result."

The changes induced in the neuron by alcohol are not peculiar, but may be brought about by the continuous influence of many different toxic agents.

From the researches of Andriezen and Berkley it is clear that the action of alcohol in bringing about insanity arises chiefly from the direct effect of this substance on the nerve cell, the deleterious action on the bloodvessels being secondary. Berkley found comparatively little change in the supporting elements in rabbits poisoned by alcohol.

Pachymeningitis.—Pachymeningitis interna, hæmorrhagica, cerebralis, and spinalis is one of the rarer effects of the prolonged use of alcohol. Both the cerebral and spinal forms are usually met with together.

The SYMPTOMS are chiefly due to the cerebral involvement, the spinal symptoms being usually obscured, or they may be entirely wanting.

Meningo-encephalitis and Myelitis.—Various degrees of meningo-encephalitis and myelitis are met with after death in chronic alcoholics. With the exception of slight degrees of mental instability, no symptoms may be present during life to lead one to suspect any organic changes. Such changes are by no means characteristic of chronic alcoholism, as they are not uncommonly found in old people from various forms of chronic wasting diseases.

Alcoholic Epilepsy.—Convulsions of an epileptic character are not an infrequent effect of the occasional and immoderate use of alcohol. Very recently there were in the wards of the Royal Victoria Hospital of Montreal three men, all suffering from alcoholic epilepsy. In each case the convulsions occurred during a period of prolonged drinking, and were repeated during each bout, and only then. There is no doubt that alcohol may set up an epileptic habit, the fits recurring after a time from other causes and irrespective of whether alcohol is taken or not.

It is said that there is a greater tendency to the status epilepticus in alcoholic than in idiopathic epilepsy.

Peripheral Neuritis.—Alcohol is the most frequent cause of peripheral neuritis. It is especially frequent in females. The typical form of alcoholic peripheral neuritis is when there is marked loss of power in the extremities, with loss of tactile sensation and hyperæsthesia of the skin, spontaneous pains, and marked muscular tenderness. Less common forms are—(1) the purely motor type, (2) the purely sensory type, and (3) the tabetic type, constituting the condition often called "pseudo-tabes alcoholica." It is rare, however, to meet with a case of a pure type, usually the motor, sensory, and ataxic symptoms being present to a greater or less degree.

The cranial nerves may also be the seat of neuritic changes; the vagus and optic nerves are more likely to suffer than any of the others. These changes may be met with alone or in combination with inflammation of the nerves of the extremities.

TREATMENT OF CHRONIC ALCOHOLISM.—The treatment of the alcoholic habit presents very great difficulties, and is rarely successful in chronic confirmed cases. Withdrawal of the alcohol is the first step. Whether this should be done suddenly or gradually is a matter on which

physicians who have had special opportunities of study are not by any means fully agreed. Many different agents are recommended as partial substitutes for the alcohol during the period of its withdrawal. Strychnine, capsicum, and the aromatic spirits of ammonia are most highly prized for this purpose by many, while others consider coffee and cold or hot water quite as valuable. Cocaine and all agents capable of bringing about a "drug habit" should be avoided. The food of patients undergoing treatment should be nutritious and given in small quantities at short intervals during the first few days.

The treatment of the alcoholic habit is rarely successful unless carried out under close surveillance in a special institution. The attempt to treat a confirmed alcoholic in private is undertaking an almost hopeless task.

Nearly every city contains one or more institutions, conducted by medical men of integrity, experience, and intelligence, where the most approved means for the treatment of these cases is carried out.

Hypnotism has been found of value in a few cases. The experience of Hazel Tucker in London and Forel in Zurich would lead us to hope that the usefulness of this means might with benefit be much extended.

MORPHINISM.

Synonyms.—Morphiomania; Morphine habit.

The morphine habit is acquired by the constant use of morphine or some preparation of it. The habit is acquired readily by those in whom there is a marked neuropathic disposition, especially when taken to control sleeplessness or relieve pain. When once contracted it is difficult to overcome it. The habit in this country, although far from rare, still bears no comparison whatever with the frequency of it in Eastern countries, especially in India.

Symptoms.—In fully developed morphinism the symptoms are usually sufficiently striking to lead one to suspect its existence. It must, however, be remembered that a person may be a morphiomaniac for years without being for a moment suspected by his most intimate friends.

The following are the chief symptoms: First of all, the patient is usually considerably emaciated, due to the action of the drug on nutrition. In consequence of the general nutritive disturbance there is physical as well mental languor. Occasionally we find decided paretic symptoms, more frequently of a general than a local character. Paralysis of the extensor muscles of the hands has been noticed in rare cases, closely corresponding in distribution to saturnine paralysis, but very rarely attended by the trophic disturbances so common in severe cases of the latter. Fine volitional tremor of the hands and tongue is apt to supervene in the case of confirmed morphiomaniacs when the accustomed drug is withdrawn.

Static and locomotor ataxia is usually observable at the same time.

Disturbance of the bladder and rectal reflexes is also an uncommon state.

The superficial and deep reflexes are rarely changed. Trophic disturbances, as frequently evidenced by the formation of abscesses at the points of hypodermic injection, point to central changes.

Pains of various kinds are complained of. The pain may be situated in a joint or in the course of the distribution of a peripheral nerve, or it may be visceral. Pain is frequently referred to the epigastrium and lower parts of the abdomen.

While the subject is under the influence of the drug the pupils are contracted. When the effect passes off they may be equally or unequally dilated. The reaction to light is lessened. Diplopia and paralysis of accommodation are now and then met with.

Hoarseness, loss of appetite, and constipation are usually present, and prove troublesome symptoms. Impotence is met with in both sexes. Amenorrhœa is the rule. The quantity of urine is usually lessened, and on examination it is the rule to find traces of albumin.

Elevation of temperature, swelling of the spleen, and other pyrexial signs are not unusual. The patient may pass into a state of marasmus and die from a slight intercurrent affection.

Cerebral Symptoms.—The symptoms pointing to mental disturbance are the most important. The confirmed morphiomaniac is, unless under the influence of the drug, not only a physical but also a mental wreck. He has lost his accustomed energy and puts off his work. The memory suffers. His moral nature is changed: from being a reliable person he becomes wholly unreliable. He cannot be trusted to do anything or to tell the truth. To procure the drug he will resort to every possible subterfuge.

Acute maniacal symptoms at times supervene when more than the usual quantity is taken. Such a state may be accompanied by delusions and hallucinations. Such symptoms are more frequent as the effect of the drug is passing off.

Insomnia is also a very constant feature. A morphiomaniac may pass by degrees into a state of subacute and chronic dementia, with delusions. It, however, rarely proves incurable, provided the drug is discontinued. The extreme grades of mental degradation are rarer from morphine than from other stimulant and narcotic agents.

Prognosis.—The prospect of a patient being able to completely get rid of his habit is far from bright. Many do succeed for a time, but it is the rule to meet with relapses. It is well known that it is more difficult to recover from a second than a first attack. It is not at all uncommon to meet with patients who, as far as they are concerned themselves, have no desire to get better. In cases where morphine has been taken to relieve pain, and where it continues, it is rare to meet with a person who possesses the fortitude necessary to abstain from taking the drug.

The danger to life directly is but slight, but indirectly it is considerable. Owing to the patient's lessened resistance, he much more readily succumbs to an intercurrent affection, as pneumonia.

Treatment.—(*a*) *Prophylaxis.*—As the majority of cases of morphinism met with in this country are, in the first place, taught the use of the

hypodermic syringe, in physicians it is especially incumbent to study well all cases before recommending such a procedure. If the patient is suffering from a functional nervous affection, it is a good rule to not only abstain from the prescribing of morphine in any form, but to especially warn the patient against its use. In organic incurable affections the pain may be so troublesome that the constant use of morphine is necessary, being the lesser of two evils. In functional affections morphine can rarely do good, and usually great and irreparable mischief. It is especially incumbent in a physician to be careful in recommending morphine to counteract sleeplessness. A patient should never be given or taught the use of a hypodermic syringe unless it is in cases of organic affections that are likely soon to prove fatal.

(*b*) *Treatment of the Habit.*—For the successful treatment of established morphinism there is only one remedy, and that is the withdrawal of the drug. The only safe and effectual way in which this can be accomplished is by gradually diminishing the quantity. This can rarely be successfully done except in an institution controlled by an experienced physician. It is all important that the patient should be carefully watched, and this cannot be done unless in a place of the kind mentioned. Constant care and watchfulness are especially called for in patients who have been long addicted to the habit, and in those who show any evidence of cardiac or arterial degeneration. Neuropathic patients may show during the treatment symptoms of mental disturbance. They become greatly depressed. They may even attempt suicide. Such patients require especial care. Especial attention should be given to the diet, frequent liquid nourishment being indicated. Every measure to stimulate the appetite and promote digestion should be considered, and employed when practicable.

Hydrotherapeutics, as carried out in modern sanitaria and water-cure establishments, is an important auxiliary. For some days it is advisable to keep the patient in bed, but as he gradually gains ascendancy over his habit regular exercise at stated intervals is to be recommended. He should be encouraged to persevere. Much of the success, both temporary and permanent, depends upon the personnel of the physician.

The drug treatment of morphinism is of secondary importance. Digitalis, sparteine, strychnine, and aromatic spirits of ammonia are indicated as cardiac tonics and stimulants. Alcohol in some form may also be called for, and used with benefit. Before resorting to direct hypnotics to allay the distressing restlessness and sleeplessness recourse should be had to general measures, as warm baths at bedtime, cold applications to the head, warmth to the feet, etc. If it is necessary to resort to a direct hypnotic, then the least likely to do harm should be chosen, as trional, sulphonal, paraldehyde, or hyoscine. The substitution of morphine with cocaine, calomel hydrate, or similar agents is a practice fraught with danger.

INFECTIOUS DISEASES COMMON TO MAN AND ANIMALS.

INFECTIOUS DISEASES COMMON TO MAN AND ANIMALS.

GLANDERS.

By JAMES LAW, F. R. C. V. S.

Synonyms.—Malleus; Equinia gravior; Farcy.

Definition.—An acute or chronic infectious disease attacking the lymphatic system, especially of the upper air passages or of the skin, and characterized by a progressive hyperplasia with a strong tendency to degeneration and ulceration. As affecting the skin it is usually known as *farcy*, whereas in the deeper organs it is known as *glanders*. The combination *farcy-glanders* is usual in acute cases.

Animals Susceptible.—This is especially a disease of solipeds (horse, ass, mule, etc.), but is inoculable on most mammals (excepting those of the genus Bovis) and on the human being. In addition to bovine animals, the house and the white mouse, the rat, the hen, and the linnet prove refractory. Sheep, swine, and pigeons can be inoculated, but not always with certainty. The ass is especially susceptible and contracts the disease in its worst form, so that it is usually selected for test inoculations. Next to the ass, the guinea-pig is the most serviceable. White and house mice are insusceptible to glanders, but are susceptible to strangles, whereas field mice are susceptible to glanders, but insusceptible to strangles, thereby affording a means of distinguishing these two affections. Glanders inoculated on the dog advances for eight to fifteen days; then the ulcer becomes stationary for one or two weeks, and ends by cicatrization and complete recovery. In the cat death may arrive in two weeks, with articular lesions. The virus has been found to be less potent on other animals after several passages through the cat (Zakharoff), whereas its potency was enhanced by passing through the pig or lion (Gamaléia, Trasbot).

Geographical Distribution.—Glanders exists in the greater part of the civilized world, whether in the eastern or western hemisphere, but its ravages are greatest in the temperate zones, where enterprise is most active and the movement and sales of horses are the most numerous. Thus in Norway there are but 6 cases yearly for 100,000 horses, in Belgium 138, and in France until recently 1130 (now 42). In the United States it seems to have been largely confined to the Northern States before 1861, but spread over the South in connection with the war. Mexico it is said to have entered with the American cavalry in 1847. Similarly Portugal is said to have been exempt until the Napoleonic invasion in 1797. Central Hindustan was said to be free from it until the war with Afghanistan in 1878. In all these cases the movements of cavalry and artillery and of commissariat trains spread the affection widely. In our own case the sales of horses and mules at the close of the war produced a very general diffusion from which we are still suffering.

Insular places escape, especially if far from the mainland and free from importation of horses. Thus glanders is very rare in Iceland and the Faroe Islands, with 35,000 horses, and in Bornholm with 7000, while in Australia, Tasmania, and New Zealand it is unknown.

Etiology.—The one essential cause of glanders is the *bacillus mallei*, a small rod-shaped body in length about one third the diameter of a red blood globule.

Though this germ is most abundant in the tissues of the neoplasms, and in the discharges from the open abscesses and ulcers, and especially those of the nasal and pulmonary mucosa, yet no vascular tissue of the body possesses an immunity, and infection has been conveyed by transfusion of the blood of the badly affected glanderous animal, as well as by the mucus, tears, saliva, sweat, urine, and milk. It has been transmitted by coition, and from mother to fœtus, even when no apparent disease of the placenta existed. Many failures, however, occur when these natural secretions are inoculated.

Infected secretions, and above all the discharges from the specific sores, may dry upon any solid body and be transmitted by mediate contagion, or as dust they may be carried on air currents and infect animals at a distance. Among the common channels of mediate contagion may be mentioned the racks and mangers in livery stables and public feeding places, public drinking troughs, buckets, harness, clothing, combs, brushes, rubbers, solid food, litter, the hands and clothes of attendants, poles of wagons, etc.

In addition to such accessory causes must be named all those conditions of life which increase the susceptibility of the animal. While there is undoubtedly a variable susceptibility in different horses and other solipeds, yet in all the main sources of increased susceptibility are to be found an impairment of the general health and vigor. All chronic and exhausting diseases predispose, so that before the discovery that glanders arises from infection alone it was thought to be the winding up of all wasting and debilitating disorders in the horse. Similarly, debility from low feeding and overwork has often been shown to be followed by a great extension of the malady, while a better diet and regimen reduced the number of cases. Dark, damp, and cold stables have similarly determined a great increase of cases, which diminished with sunshine, warmth, and dryness. Finally, impure air, and especially such as has been breathed repeatedly and largely robbed of its oxygen, is perhaps the most potent of all accessory causes. In the British military expeditions prior to 1868 the cavalry sent by sea and often battened down during storms, were usually decimated by glanders or worse. Since that date, with the rigid exclusion of glandered horses from this arm of the service and the purifying of the transports, escape has been the rule. Prior to 1836 the French cavalry stables were very badly ventilated, and glanders carried off 140 per 1000 horses yearly; at that date improvements mainly in ventilation reduced this loss to 34, and later still further improvements lowered the glanders losses to 2. In close stables, and especially cellar stables, any existing glanders spreads quickly and in its worst forms.

Bacillus Mallei.—This was described and figured by Christol and Kiener in 1868 as a chain of globular bodies in a common sheath. In

1881–82, Bouchard, Capitan, and Charrin in France and Löffler and Schütz in Germany investigated and demonstrated the germ by cultures and otherwise. The early work of Kitt and Weichselbaum was no less important.

The germ is rod-shaped, 2 to 5 μ long by 0.5 to 1.4 μ thick, or about the length of the *bacillus tuberculosis*, and a little thicker. It grows thicker, and even somewhat shorter, in liquid cultures, still more emphasizing the difference. The germs also differ widely in their susceptibility to stains and bleaching agents. The glanders bacillus stains more speedily than that of tuberculosis, especially in alkaline solutions, and it parts with its color in acids far more quickly.

FIG. 53.

Bacillis of glanders (*bacillus mallei*) (Abbott).

FIG. 54.

Malleus bacilli in a malleus nodule: × 700 (after Plügge).

The *bacillus mallei* is aërobic (facultative anaërobic), non-motile, and parasitic. It grows, however, in many nutrient culture media, and notably in glycerin agar or on potato, forming on the latter long filaments. The best temperature for culture is 37° C., and it will not grow below 22° C. nor above 42° C. On agar in forty-eight hours it forms a dense opaque milk white layer, changing later to yellow and brown.

Its vitality is destroyed by a temperature of 100° C. for two minutes, or of 55° C. for ten minutes (Löffler). It is devitalized by corrosive sublimate (1 : 5000) in two minutes; by permanganate of potash (1 : 100) in two minutes; by carbolic acid (5 : 100) in one hour; by sulphate of copper (2 : 100) in ten days. Löffler found that in the desiccated discharges vitality was preserved for months. Cadéac and Malet found that sterilization was effected if drying took place very slowly. In putrefying materials virulence lasts for fourteen to twenty-four days, in water for fifteen to twenty days. In the shade in the moist air of the stable it may be preserved for four months.

PATHOLOGICAL ANATOMY OF CHRONIC GLANDERS.—The presence in the tissue of the glanders bacillus and its toxic products usually results in an active proliferation of small round cells (lymphoid) which form

nests like miliary tubercles enclosed in a fibrous stroma. These centres of cell development may become confluent and form larger masses like peas or greater. The centre of the group tends to degenerate, the cells undergoing fatty degeneration and breaking down into a granular débris. There are formed sanious abscesses, ulcers, and cicatrices. In other cases, instead of this softening of the neoplasm, the fibrous stroma becomes denser and an indurated nodule results.

1. On the respiratory mucous membrane two forms occur, and often coexist. After a short period of nasal catarrh in which there is a more active production and granular or purulent degeneration of the mucous corpuscles, the morbid cell proliferation extends into the fibrous substance of the mucosa and the foci stand out as grains of sand or millet-seeds on the surface. By confluence of two or more they form larger nodules like peas or greater. These are whitish or reddish gray, with a congested peripheral zone and may be isolated or in groups. As they increase the whole mucosa often assumes a dark red or leaden hue, which is, however, less marked as the disease is more chronic. The clusters of lymphoid cells in the centre of the nodule are the palest portion of the lesion, and early break down into a fatty granular débris or pus, which is discharged by bursting, leaving an ulcer of a superficial round or oval or of a deep irregular form. The depth of the ulcer is of a yellowish or lardaceous appearance mixed more or less with red, and the edges are often elevated and overhanging. When two or more ulcers have become confluent the edges are irregular and jagged. The superficial ulcers may heal without leaving any cicatrix, while the deep ones tend to extension laterally or perpendicularly, perforating the mucosa, the cartilages, or even the bones. When these deeper or confluent ulcers cicatrize a distinct stellate or otherwise puckered condition remains. These lesions are common on the septum nasi, the turbinated bones, or are seen after death on the ethmoid cells, on the mucosa lining the antri, or on the Eustachian tubes or pouch. The larynx, too, may be involved, especially the region of the arytenoid cartilages, the epiglottis, or ventricle. In some cases there is diffuse infiltration of a portion or the whole of the nasal mucosa, which is greatly thickened and congested, of a dark red hue, and the seat of superficial ulcers like pinheads or larger, and in certain cases of cicatrices. The cicatrices, however, do not always follow on the healing of ulcers, but result in some instances from a fibroid transformation of the neoplasm.

The bacilli are found between the lymphoid cells, but are comparatively in small numbers in the more chronic cases. Swelling of the submaxillary lymphatic glands is a common feature.

2. The lungs are usually the seat of miliary or larger nodules in chronic glanders. These are gray, translucent, or white, with a dark red zone of investing congestion. If older they may show a dirty gray or yellow necrobiosis in the centre, which may burst and discharge into a bronchus or may undergo calcification. The tissue surrounding such caseated masses has a yellow lardaceous aspect and an irregular, uneven surface very different from the smooth walls of an inspissated abscess or a degenerated hydatid. Secondary nodules appear attached to or adjoining the capsules of these softened masses, especially along the course of the lymphatic vessels, which are inflamed and thickened

(corded). The bronchial and mediastinal lymphatic glands are usually implicated.

In place of miliary or fusiform tubercles there may be extensive lobular or lobar pneumonia, starting usually in a perilobular lymphangitis and determining central neoplasms in size from a hazelnut to a mass of several inches in diameter, with necrobiotic, or even purulent centres, or of a soft grayish white sarcomatous aspect, or hard and resistant from the abundance of the fibrous stroma. In their intimate structure these show the same nests of lymphoid cells in a fibrous stroma, spindle shaped cells, and degeneration products as in the nose lesions.

As concomitant lesions in certain cases are found peribronchitis, bronchitis, bronchiectasis, and pleurisy with recent vascular fringes or adhesions.

The pulmonary lesions are primary, from inhalation, in exceptional cases, but usually secondary from the primary foci in the nose, skin, or elsewhere, in the line of the systemic circulation, the bacilli, blood-borne, finding their first opportunity for rest and development in the walls of the pulmonary capillaries. The early implication of the pleura appears to come from a reflux in the pulmonary lymphatics determined by active or deep inspiration.

3. The lymphatic glands on the line of circulation from any existing disease focus are early implicated. Thus the submaxillary glands are always involved on the same side with the affected nasal chamber and the bronchial and mediastinal glands in cases of pulmonary glanders. There is first an active parenchymatous inflammation with swelling and tenderness, and later a firm induration with diminished vascularity. At first there is the same active proliferation of small round cells, and later an increased fibroid development. Here and there, however, are grayish white nests of cells or yellowish centres of caseation. An hypertrophy of the fibrous covering is a barrier to rupture and discharge of the softened contents, especially in the case of the submaxillary glands.

4. In cutaneous glanders (farcy) the most characteristic features are the formation of rounded nodules (farcy buds) in the derma and in the subcutaneous and intermuscular connective tissue, and the inflammatory thickening (cording) of the lymphatic vessels. The histological elements are the same as in the other glanderous neoplasms. The nodules in the skin, of the average size of a pea, rapidly soften, burst, and form an ulcer discharging a serous or glairy liquid. The nodules in the connective tissue attain the size of a hen's egg to a large orange or greater, and these, too, rapidly soften and discharge a more or less glairy purulent fluid, and often prove refractory to heal.

5. Other internal organs may be found to be the seat of the specific nodules about in the order following: spleen, liver, kidneys, and testicles. The histological features do not differ from those met in other organs.

Pathological Anatomy of Acute Glanders.—In this the essential microscopic features do not differ from those of the chronic type; only the disease makes rapid progress, invades successively the different parts of the body, determines active local inflammations and exudations, and early death. If it has commenced in a limb, there may

be an inflammatory engorgement of a joint or of the entire member, which for a time hides the nodules and indurated lymphatic vessels. If it starts in the nose, there is excessive swelling of the mucosa and submucosa, with dark red discoloration and rapidly advancing ulceration. The submaxillary lymphatic glands undergo rapid swelling and may even, exceptionally, rupture and discharge; and extensive secondary nodules and acute abscesses in the lungs and other internal organs are met with.

One striking feature of glanders is the friability of the bones, especially in chronic cases; another is the excess of white globules in the blood, the formation of which appears to be stimulated by the irritation of the lymph glands and of the bone marrow.

Symptoms of Acute Glanders.—*In the Horse, Ass, and Mule.*—The disease is common in the ass and mule, but infrequent in the horse. After an incubation of three to five days the animal has a rigor, elevated temperature, a profuse muco-purulent discharge from the nose, sometimes mixed with blood or alimentary matters arrested in the pharynx; if unilateral, this is especially characteristic; running from the corresponding eye is not uncommon. The margin of the nostril swells, the mucosa is dark red, infiltrated, marked with pea-like yellowish elevations with red areolæ, which in a few days become eroded into increasing ulcers. The discharge is sticky, matting together the hairs and skin of the nostrils. The submaxillary lymphatic glands on the affected side swell, feeling like a bag of peas, tending to adhere by the inflamed (corded) lymphatics to the bone, the skin, or root of the tongue. There may, however, be a uniform swelling filling the whole intermaxillary space. There is early implication (cording) of the cutaneous lymphatics of the cheek and of the body, with nodules, exudations, or arthritis. The condition is rapidly aggravated, and death ensues, usually from suffocation, from the sixth to the fifteenth day.

Symptoms of Chronic Glanders.—*In the Horse.*—The disease may begin with a rigor, but usually the onset appears insidious. There may be muco-purulent discharge from one or (less significant) from both nostrils, becoming sticky and sometimes streaked with blood. The previous occurrence or coincidence of intermittent or continued lameness, arthritis, œdema of a limb, swelling of a testicle, cough, or epistaxis is significant. Still more significant is the nodular, comparatively painless swelling of the submaxillary lymph gland on the same side, feeling like a mass of peas and adherent to adjacent structures. The nasal mucosa is congested, of a dark red on part or all of the septum, and ulcers, superficial or deep and clean, or covered with crusts of a red, black, brown, yellow or green color, are found.

In exceptional cases the submaxillary glands only are apparently diseased, the bacillus having entered the lymph channel through the soft mucous cell or the primary lesions of the mucosa having healed over. In other cases there is only a cough and a grayish uncertain expectoration, the latent lesions being confined to the lungs. In still other cases the lesions are confined to the testicle, the spleen, or some other internal organ, and symptoms may or may not be present.

In chronic cutaneous glanders, with or without œdema of a limb, there may be a nodule on the fetlock, or elsewhere on the line of the

lymphatic vessels, with induration of the lymphatic trunks extending from it. The nodules may or may not be multiple, and they may or may not be open and discharging an ichorous or glairy liquid.

Equivocal chronic cases may often be rendered more active and distinctive by a dose of physic, and still more so by poor feeding, overwork, impure air, debilitating disease, or any other cause which deteriorates the general health. Acute glanders often follows.

By way of diagnosis, inoculation of the animal itself may be enough. Yet in chronic cases the susceptibility is usually somewhat lessened, and the absence of resulting local lesions is not to be implicitly relied on. A better course is to inoculate a healthy donkey or guinea-pig, which will develop acute glanders in six days.

A prompt and most reliable test is to inject the suspected animal with the sterilized toxic products of the *bacillus mallei* (mallein). This is the exact equivalent of the "tuberculin" test for tuberculosis, and is almost equally trustworthy. The mallein is obtained by making artificial cultures of the *bacillus mallei* in glycerined nutrient liquids, killing the bacillus by heat, filtering it out, and diluting the filtrate with phenic acid solution (2 per cent.) until 1 c.c. is the proper dose for an average horse. First used in 1888 by Helman in Russia with curative intent, it soon came to be trusted as a diagnostic agent because of the local and general reaction which it produced in cases of glanders. The hypodermic injection is made at midnight or very early in the morning, and the temperature is taken four hours later and every hour thereafter up to the sixteenth or later. In cases of glanders the temperature rises gradually to 2° and upward above normal, and falls equally gradually. The rise may last two or three hours only or it may exceed forty-eight hours. A steady rise to 1.5° above normal and gradual fall is ground for suspicion and good ground for a second test later. Atypical reactions in which there is an abrupt rise and fall are not to be trusted as indicating glanders. In addition to the rise of temperature, the glandered horse usually shows weakness, drowsiness, inappetence, staring coat, shivering or tremors, and accelerated pulse and respiration. In the seat of the injection there is active phlegmonous swelling the size of the hand or larger and lasting several days.

Symptoms of Cutaneous Glanders or Farcy.—This may be acute or chronic. In the former case it is ushered in by fever, with rigor, malaise, loss of appetite, high temperature, and suppressed secretions. There may be acute inflammation or swelling of one or more joints of the limbs, or an extensive œdematous engorgement, usually of a limb, in which, or around its margins, may be felt the inflamed and thickened walls of the lymphatics (corded lymphatics), with at intervals nodules the size of a pea or hazelnut. These rapidly undergo softening and burst, forming a deep ragged ulcer, and discharging a thin glairy, sometimes bloody fluid. If the fever is maintained, there early supervenes a fatal nasal glanders.

The chronic forms generally come on without manifest fever or general disorder. With or without extensive swelling in a joint or limb, the nodules (farcy buds) develop on the line of the corded lymphatics, on or near the fetlock or hock, or on the line of the saphena vein, and tend to burst and discharge, though they may be covered by

scabs. Between these nodules the lymphatics are hard and corded. This affection of the lymphatics is characterized by extension from below upward toward the body, whereas in the ordinary acute constitutional lymphangitis in the horse the heat and tenderness are first noticed in the external inguinal glands and extend downward along the line of the saphena vein.

Glanders in Man.

It was only in 1812 that this disease was recognized in man as being identical with that of the horse. Soon, however, many cases were reported, some acute and others chronic, and all traceable to the same source.

Etiology.—As in other animals, the one essential cause of the disease is inoculation with the *bacillus mallei*. In man it is almost always derived from the horse, and hence the disease is mainly an industrial one, attacking those that come in contact with horses—grooms, coachmen, farmers, veterinarians, horse butchers, horse dealers, soldiers, being especially liable to be infected. Handling the glandered horses with abraded or wounded hands, giving medicine, and scratching the hands on the teeth, receiving on the eye, nose, or other mucous membrane the particles scattered in snorting, drinking from the same trough or bucket with a glandered horse, and using a knife that has been employed on the sores of glanders, are well known occasions of infection. Less common channels are the infected harness, pole, or shafts, the use of handkerchiefs, towels, or clothing after a glandered man, the washing of his clothing (Elliotson), and the manipulation of cultures of the bacillus. In 1889, Dr. Hoffmann perished miserably in Vienna from acute glanders contracted from his own artificial cultures. Du Paquin of the University of Missouri also suffered through experimentation, but recovered.

Women do not constitute over 5 per cent. of the victims, and nearly all are wives of hostlers, grooms, or coachmen or are employed about stables. In 120 cases 1 only was in an infant, and that the child of a coachman who had dressed glandered horses.

The flesh of glandered horses or other animals has often been eaten with impunity, cooking and the gastric secretions both contributing to disinfect it, yet neither of these should be implicitly relied upon, since dogs, cats, prairie-dogs, lions, and polar bears have contracted the disease by eating glandered horses, and abrasions of lips, gums, and tongue are so common that immunity cannot well be hoped for. Moreover, the entrance of the bacillus through the buccal mucosa, the tonsils, or pharynx is altogether probable. Persons sleeping in stables occupied by glandered horses, but not handling them, have often suffered, apparently through the virulent discharges dried up on stalls, fodder, or litter, and then distributed as dust to be inhaled. Yet this mode of infection is rare, and horses will often stand for months in stalls near to one occupied by a glandered horse without contracting the disease.

Finally, many men are comparatively insusceptible to glanders, which serves to explain why so few suffer in infected stables, and cases like that of Decroix, who boasted that he repeatedly ate the raw flesh

of glandered horses with impunity. Inoculation with the juice of such flesh is usually successful.

Many of the human victims of glanders have been apparently healthy, vigorous men in the prime of life.

Pathological Anatomy.—In man as in animals the morbid process consists essentially in the proliferation, especially in the lymph spaces and glands, of lymphoid and fusiform cells in a fibrous stroma, resulting in coagulation necrosis or suppurative processes, ulceration, or abscess. In man, however, the formation of tumors and the enlargement of the lymphatic glands are less prominent features, and the disease more nearly resembles pyæmia. In the advanced stages pyæmia is a frequent complication. The contents of the glanders abscess, however, is more glairy and bloody, the walls are irregular, grayish or yellowish red, and ulcerating, and the surrounding tissues, especially if in the muscles, are softened and pale. The multiple neoplasms, too, in all stages of progress from the simple congestion, through the solid granulation papule or nodule, to softening or ulceration, together with the occupation of the patient, will serve to correct misapprehension. The skin papules and pustules have often been mistaken for smallpox or rötheln. The advanced specimens contain caseo-purulent contents or a glairy sanguineous fluid covering a coagulation necrosis, and are further identified by the connecting corded lymphatics. The diffuse inflammatory and œdematous lesions may be readily taken for erysipelas, but the characteristic nodules or small abscesses with reddish contents in this focus or in distant parts of the skin and joints serve to distinguish.

In the *nose* the small papules or nodules with grayish or yellowish centres, and the irregular, unhealthy, spreading ulcers, extend to the bone and cartilage, and even to the facial muscles and skin, producing the most unsightly swellings and sores. The submaxillary and sublingual glands swell in nodular form, and the intervening lymphatics become corded. Similar formations are found on the mucosa of the pharynx and larynx, the nasal sinuses and palate, the ulcers on the mouth often strongly resembling the syphilitic sore.

When the *lungs* are involved, as they often are, there may be catarrhal bronchitis, peribronchitis, lobular or lobar pneumonia, and pleuritic ecchymosis and congestion, with more or less numerous miliary or pea-like nodules of a gray, yellowish, or reddish hue, hemorrhagic infarctions, and abscesses.

Muscular lesions appear to be most common in the pectoral region and upper limb. The muscle is the seat of a cloudy swelling, a granular degeneration of the fibre, and lymphoid cells multiplying rapidly, forming a nodule which undergoes coagulation necrosis and even suppuration with yellowish, glairy, perhaps bloody contents. The wall has an irregular cloudy yellow or reddish appearance, and the swelling may vary from a pea to a pigeon's egg. Similar formations are found in the subcutaneous connective tissue and lymphatic glands.

The *bone* and *periosteum* are implicated by extension from the superposed soft parts or through the blood, small yellowish nodules appearing on or in them, and the degeneration products detaching the membrane from the underlying bone. This is especially common about the face, the cranium, and the bones of the limbs, and at tendinous insertions.

The *synovial membranes* of affected joints are the seat of congestion, miliary nodules, and abscesses, and the articular cartilage is rough and eroded.

The specific nodules and abscesses are also found in the stomach, liver, spleen, kidneys, testicles, and brain, and an inflammatory form in the brain (myelitis malleosa) is not unknown.

Lesions of the mucosæ are most prominent in the chronic forms, and those of the viscera in the acute.

In all cases the presence of the bacillus in the discharges, the scrapings of the ulcers, or the nodules is a common feature.

Symptoms.—*Acute Glanders.*—*Incubation* in acute cases is from one to three days; in chronic or subacute forms it may appear to be as many weeks.

In acute cases the initial symptoms are general malaise, weariness, headache, chilliness, and obscure pains in the muscles or joints, especially of the limbs. This may be mistaken for rheumatism or typhoid fever, but this mistake is usually soon dispelled by the supervention of local lesions. Though the infection wound may have healed, it now becomes the seat of itching, formication, pain, redness, swelling, and inflammation, which extend along the lymphatics, as shown by the red and corded lines running out from the cicatrix. Vesicles with reddish contents appear around this; the wound may burst, discharging a serous or glairy reddish fluid, and the whole arm or face may develop an erysipelatoid swelling. From this the sore may granulate and heal, and recovery ensue, but more commonly the lesions extend and the disease is generalized. The fever increases and becomes constant; there are anorexia, nausea, vomiting, sweating, constipation followed by diarrhœa, violent headache, severe pains in the joints and muscles, and great prostration. If there are no local lesions, infection having occurred by the lungs or stomach, it may still be mistaken for typhoid fever, but this will be corrected by the history and the later developments.

Soon the skin of the face or body shows red spots which develop into pealike pustules, like smallpox, and these bursting discharge a thick fetid, bloody matter. Or the swellings may be large, rounded, firm, painful, and gradually softer and fluctuating. When bursted or opened they show yellowish red irregular walls enclosing the whitish contents. These may be circumscribed or general over the whole skin, and they may expose muscles, tendons, or bones.

When the nose is affected, which occurs less constantly in man than in the horse, there is a thin, sticky, catarrhal flux, with occasionally a brownish, greenish, or reddish discoloration, and fœtor. Nodules and ulcers with irregular borders and lardaceous yellowish base can usually be seen on the mucosa or on the skin adjoining the nostril. The nose or whole face may swell, become tense and ulcerate, and the lymphatics leading to the lower jaw become hard and corded. Catarrhal discharge and ulceration may appear in eye and mouth, the breath becomes intolerably fetid, and swallowing and even breathing difficult from implication of pharynx and larynx. The breathing is snuffling or oral, the nose being closed by swelling, scabs, and discharge, and the nostrils agglutinated together.

The implication of internal organs may be shown by cough, pain in

the chest, bronchi, and other morbid chest sounds, nausea, vomiting, fetid diarrhœa, jaundice, abdominal tenderness, albuminuria, and the presence of leucin, tyrosin, and other imperfectly oxidized products in the urine.

The pulse becomes rapid, small, thready, or imperceptible; the temperature may reach 106° F., and the mind may be clouded or delirious. Death ensues from collapse following stupor and coma, or from dyspnœa.

Chronic Glanders.—The constitutional disorder is usually present from the first, but is much less marked. Ulceration appears in the infection wound, or swellings and corded lymphatics in its vicinity; also swelling of the lymphatic glands. These are usually on the bare parts of the skin, the face, and upper extremity. The ulcers are indolent, and, though healing in part, will give rise to nodules and abscesses around them, which burst, discharging a sanious pus, and are tardy to heal. Abscesses may appear at distant points or gradually over the body with erysipelatoid inflammation, especially of the face, and arthritis. Thus the acute and fatal form supervenes.

When the nose is affected the lesions do not differ from those seen in the acute form, but they are more circumscribed and indolent. The nodules, ulcers, and sticky, foul discharge agglutinating the nostrils are no less characteristic. This may not appear in more than one half the cases, and often not for months after infection. The mouth and throat become involved, with fetor, salivation, difficult deglutition and breathing, and the implication of the lungs is shown by cough, dyspnœa, and morbid chest sounds.

There is a variable but remittent fever, and the patient becomes pallid, emaciated, and debilitated, and the disease merges into the fatal acute type.

When the symptoms improve in mild chronic cases recovery may be hoped for. The fever decreases, the pulse improves, the swellings subside, the ulcers and abscesses granulate and heal, and appetite and digestion improve. Recovery is slow, and from four months to as many years may be required to effect it. With serious lesions of the lungs or other internal organs difficult breathing, general debility, and weakness are persistent.

Prophylaxis.—The prevention of glanders in man can only be obtained by its extinction in the equine family. But this will never be accomplished by present methods. Laws forbid the keeping of glandered horses, but they are largely a dead letter because there is no proper machinery for their execution. The application of the mallein test to all glandered studs, the destruction of all glandered horses, the disinfection of carcasses, stables, harness, vehicles, utensils, fodder, litter, manure, would soon make the disease extinct. Until this can be effected all who handle horses should be instructed in the danger, and enjoined never to touch a suspected animal nor anything belonging to him with any sore on the hands; to wash hands and face in a solution of carbolic acid (1 : 200) after handling a glandered animal or anything belonging to him or with which he has been in contact; to burn the manure of the affected animal, to destroy or disinfect the stall, harness, and utensils, to boil all clothing that has been on the horse or his attendants, and generally to guard against any possible channel of contagion.

TREATMENT.—*In Animals.*—In view of the danger to man some countries legally prohibit the treatment of glanders in animals. While a sound economy and an enlightened sanitation demand the purchase and killing of all glandered horses at public expense, yet it must be allowed that in the dry atmosphere of the Northern States, and especially in the Rocky Mountain region, glanders is by no means so fatal as in Europe. When a State has no systematic method of extinction, with indemnities and penalties, a horse-owner may claim a right to treat his chronic cases, but he can never have a right to expose them on the highway or in any public place. They should never be left in the same stable with other horses. The unbroken nodules on the skin may be treated with iodized phenol or they may be injected with carbolic-acid solution (1 : 200). The open sores may be injected or washed with this same or with a solution of permanganate of potash (1 : 60). Active caustics are sometimes used, such as iodized phenol and strong solutions of sulphate of copper or of iron, or chloride of zinc or of mercury. Iodoform makes an excellent application. For the nose weaker solutions may be used, as mercuric chloride (1 : 5000). The animal should be kept, if possible, in the open air, on a generous diet and with moderate exercise. As tonics quinine, sulphate of copper, biniodide of copper, nitrate of baryta, arsenic, and strychnine have been given with success. Arsenate of strychnine 2 grains daily and bisulphite of soda $\frac{1}{2}\overline{3}$ thrice a day may be specially commended.

In Man.—In the early stages the inoculation wound should be cauterized by a white hot iron or electric cautery or by undiluted mineral acid. Ulcers and open sores may be similarly treated, or they may be washed with carbolic acid (1 : 200), permanganate of potash (1 : 30), chlorinated water, or mercuric chloride (1 : 2000). Erysipelatoid swellings may be freely injected with chlorinated water or permanganate of potash solution, and covered with a compress soaked in the same, evaporation being prevented by oiled silk or gutta-percha cloth. The nose should be treated by insufflations of iodoform, by creasote water, or by carbolic acid solution. Finally the general health must be most carefully attended to, pure air, nourishing food, stimulants, beef tea, wines, etc., the regulation of all the natural functions, and finally tonics, such as quinine, iron, arsenate of strychnine, are demanded. Fever and other distressing symptoms must be met according to indications, though febrile cases are usually fatal. As an accessory the internal use of antiseptics, such as sulphites and iodides, is to be commended.

ANTHRAX.

By JAMES LAW, F. R. C. V. S.

Definition.—Anthrax is an acute infectious disease occurring in herbivora (cattle, sheep, goats, horses, asses, rabbits, buffalo, deer, elk, elephants, camels,) and omnivora (swine), and communicable to nearly all warm-blooded animals, including man. It is characterized by the presence in the diseased tissues or liquids of the *bacillus anthracis*, by enlarged spleen, by delayed oxidation of the blood, by destruction of the red blood globules, by capillary embolism, by extravasations or exudations, and by local gangrene.

Etiology.—The one essential cause of the disease is the entrance into the system of the bacillus anthracis or its spores, yet many accessory conditions are so important that their removal will go far toward the local extinction of the malady.

Soils that preserve the bacillus and spore in a virulent state are dense clays, wet soils, undrained deltas, bottomlands and basins, drying ponds and lakes, and soil rich in decomposing organic matter and evolving ammonia or otherwise neutral or slightly alkaline from the presence of lime. In other words, it is such soils as contain food for the bacilli and admit only a limited amount of oxygen. When such soils are thoroughly drained and rendered porous and aërated, the bacillus perishes or loses its pathogenic property, as it does in sandy or gravelly soils with natural drainage. For the same reason thorough cultivation and the frequent exposure of an infected soil to the air tends to rob it of its virulence. On the other hand, the bacillus retains its potency long in the mud of swamps, ponds, lakes, and wells, and will infect through the drinking water.

Season is a potent cause, the dry heats of summer and autumn evaporating the water and leaving the dust charged with the bacillus to blow on the vegetation and thus reach the victim. Sometimes the hard baked surface soil imprisons the germ, which escapes after this has been broken up by rain. In a wet season, too, the grasses are torn up and the stock are infected by the bacilli in the earth adherent to the roots. For the same reason turnips, beets, and other roots may convey the disease through the infected soil adhering to them when eaten. Sometimes a heavy rainfall will cause widespread infection, the bacilli being washed away into streams, ponds, and other drinking places.

The *graves* of anthrax victims are always extremely dangerous and may become increasingly so when the soil water rises to the surface bearing the bacilli. *Earth-worms* also bring the germs to the surface and deposit them in the little worm casts, in which they have been demon-

strated by inoculation and otherwise. Rats and mice may also exhume the virus by burrowing into the graves.

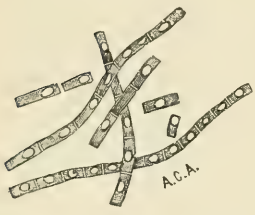
Flies convey the germ from animal or diseased products or carcass to animals, especially, the house flies, horse flies, blow flies, etc., which suck the blood and infecting liquids and carry the germ on feet or proboscis or in the intestines and deposit it on other animals, and especially on sores.

Ground bones have been charged with infecting soils, while harness, implements, hay, straw, and other fodder will convey the disease to stock. To feed hay from infected meadows is not so dangerous as to pasture them when damp, yet the dust blown on such hay will infect animals in midwinter with a temperature at zero.

Infection direct from the soil is most frequent in late summer and autumn, producing enzoötic and epizoötic outbreaks, while winter cases may seem sporadic, yet even these may be numerous and the infection may pass through unexpected channels. Thus cats, dogs, and horses perish by licking the blood of a defunct ox, and healthy animals suffer from following the sick in feeding from the same manger or rack. One of the most fruitful causes of anthrax is leaving the bodies of the victims in the pastures unburied or only partially buried. Under access of air the bacillus forms spores which in a suitable soil or dry condition may be preserved indefinitely. Dogs, too, and wild animals devour the carcass, and even if they escape infection they carry it on their jaws and legs and sometimes directly inoculate it by a bite.

Certain conditions operate on the exposed animal to make it more receptive. A hot sun producing a febrile condition and aggravated by privation of water, cold rain or snowstorms, lying on the wet or frozen earth, eating frosted vegetables, or, indeed, anything that causes chill or temporarily lowers the vitality, will act in this way. Both chicken and frog are normally insusceptible, but the chicken succumbs if its body is chilled, and the frog if its temperature is raised to that of a warm-blooded animal. Plethora predisposes, and thus the victims are often animals that have been thriving most rapidly. Young animals, too, and those fresh from a healthy locality are especially susceptible, never having been inured to the toxic products of the bacillus.

Fig. 55.

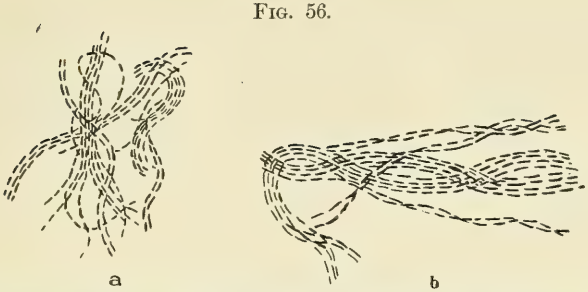


Threads of *bacillus anthracis* containing spores; × about 1200 diameters (Abbott).

Bacillus Anthracis.—The bacillus anthracis was demonstrated in anthrax fluids by Pollender and Brauel in 1849, but, failing to recognize the presence and importance of the spore in infecting liquids from which the bacillus was absent, they concluded that this organism was not the etiological factor. Davaine, in 1863, showed that it was the real cause of anthrax.

As propagated in the living animal, the bacillus is a rod 5 to 20 μ long and 1 to 1.25 μ broad. It stains well with aniline colors and also by Gram's method. It is aërobic, yet grows at the bottom of a stab culture, and is sterilized by exposure for six or eight hours, in thin layers, to full sunshine in free air. It is non-motile, unlike the bacillus subtilis and other saprophytes which strongly resemble it morphologically. It

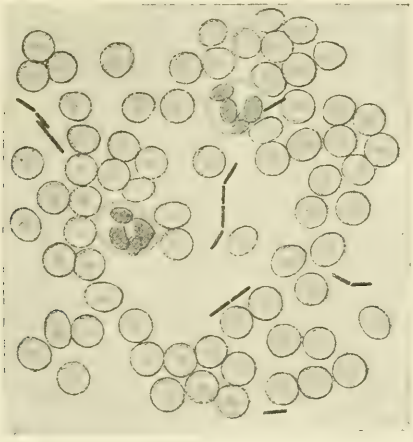
FIG. 56.



Bacillus anthracis: plaited and twisted threads seen in fresh growing cultures; × about 400 diameters (Abbott).

grows readily in ordinary culture media that have a slightly alkaline or even a neutral reaction, forming long filaments which in free air pro-

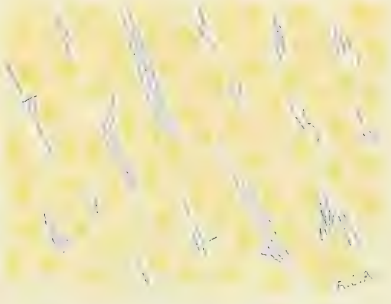
FIG. 57.



Anthrax bacilli in the blood of a guinea-pig thirty-six hours after inoculation (Charcot).

duce endogenous spores. These spores never form in the living tissues or fluids, where air is deficient, but they are produced after death on the

FIG. 58.



Anthrax bacilli in liver of mouse; × about 450 diameters. Bacilli stained by Gram's method; tissue stained with Bismarck brown (Abbott).

surface of the carcass, on the hair, wool, fur, bristles, hides, or on spilt blood or infecting discharges. In slightly acid media and in such as contain carbolic acid (1 : 1000) spores will not form. The dry spores can be preserved for years without losing any of their virulence. They are only destroyed in dry air by three hours' exposure to a temperature of 140° C., but in water they perish in ten minutes at a temperature of 100° C. The bacilli are killed in ten minutes at 54° C., and in two hours in solutions of carbolic acid (1 : 300), mercuric chloride (1 : 10,000), or hydrochloric acid (1 : 1100).

Prophylaxis.—Anthrax being an enzoötic disease primarily dependent on the condition of the soil, thorough drainage and, to a less extent, culture, are means of preventing the affection. Where infected lands cannot be drained they should not be used for pasturage, but devoted rather to the raising of crops that will be cooked before they are consumed. The bodies and stalls of the sick should be washed with an acid solution to prevent the sporulation of the bacillus. Carcasses should be left unopened, and the whole surface and air passages treated with hydrochloric acid or chloride of lime. Sporulation does not take place in the interior of the carcass. The carcass should be burned, disintegrated in a mineral acid, or, if buried, it should be conveyed in a closed vehicle from which nothing can drop on the way, and the grave should be in a fenced place, distant from wells, streams, and pastures, and in an open, porous sandy or gravelly soil, in which the infection will soon disappear. The manure should be burned or saturated with a mineral acid, and not applied to pastures or meadows. Any excretion, blood, or other product of the diseased or dead animal should be saturated with a strong mineral acid or with carbolic acid. The stall where the diseased animal has been should be cleansed and thoroughly washed with carbolic-acid solution (1 : 300) or mercuric-chloride solution (1 : 500). The sick animals must be debarred from common drinking or feeding troughs, and from buckets used for other animals, and all dogs, chickens, pigeons, and other animals must be carefully excluded from their stalls. It need not be added that the sale of their milk, flesh, skins, wool, hair, or bristles is to be severely condemned.

In districts which cannot be drained and rendered wholesome many of the young become inured to the poison by receiving the toxic matters in small, non-fatal doses in their milk, and later in their food and water, and when attacked the disease is mild and they recover. This can be availed of artificially in various ways. Thus cattle may be safely inoculated with the bacillus which has passed several times through guinea-pigs or mice. Pasteur cultivated the bacillus in bouillon at 42° C., thus preventing sporulation, but then left it twenty days without reseeding on a new flask, and found it had become non-fatal to the larger animals. It required a longer rest to make it harmless to the small ones. Chauveau and Toussaint heated the cultures to 55° C. for one hour, and thus rendered them non-fatal to the larger animals. The last two methods have been employed for inoculation of many thousands of animals in anthrax districts with the effect of giving them immunity. Among the drawbacks to the method is the risk of having the germ assume a greater virulence by passing through a young and susceptible subject or one with excess of lactic acid in its system as the result of severe muscular

exertion, and the danger of infecting through the inoculated animals dense soils which had not previously harbored the bacillus. It should be reserved, therefore, for cattle on land already infected or so porous that infection cannot survive in it.

A safer method was foreshadowed by Toussaint in 1880. He filtered anthrax fluids and injected the germ-free liquid, with the effect of conferring immunity. Having assured myself of its efficacy in other self-limiting diseases, I in 1884 applied this to anthrax. Heating the anthrax blood or serum to 158° F. for one hour and injecting one drachm per head on each of two successive days, I have never failed to arrest the disease in a herd of cattle. Chamberlain, Roux, and Hankin have lately had equal success with toxic products of the cultures. Care must of course be taken that the blood has not been allowed to sporulate before the heating.

A new field of therapeutics of this disease in animals is of interest, from the hope that some such method may yet prove successful in man. Bouchard, Charrin, and Guignard find that rabbits with a fatal dose of anthrax are preserved by one or two injections of culture of *bacillus pyocyaneus*. Emmerich, Pawlowsky, and Friedenreich have found the same good results from cultures of *micrococcus prodigiosus*, *staphylococcus pyogenes aureus*, or *streptococcus erysipelatus*, and Woodhead and Wood find that the sterilized cultures of these are equally successful.

Anthrax in Man; Malignant Pustule; Internal Anthrax.

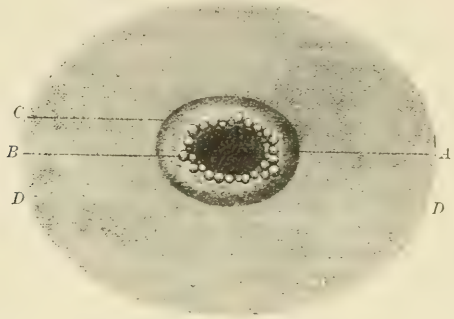
Etiology.—Anthrax in man is almost invariably the result of infection from animals, yet there is no reason why man should not be infected directly from soil or water containing the bacillus or spore. The common source, however, makes this essentially an industrial disease, which attacks employés at rendering works, butchers, tanners, workers in leather, rags, wool, hair, bristles, hides, bones, hoofs, furs, felting works, glue factories, shepherds, cattle men, horsemen, veterinarians, and which appears largely on the uncovered portions of the body (face, hands, neck, arms). The local anthrax is especially conveyed to man by bloodsucking flies (house flies, bluebottles, mosquitoes), or, when more direct, it is from hides and other animal products derived from anthrax regions (Russia, Armenia, China, South America). Yet even in our home products there are many infecting articles, so that workers in these products are often exposed. As derived from flesh the bacillus perishes in the acid secretion of a healthy stomach, so that it is only the spores that can escape and determine intestinal anthrax. If introduced by inhalation, as from dried hides, hair, wool, bristles, and rags, it usually develops first in the bronchia and extends later into the lung tissue and blood. An occasional infection takes place from man to man through lancing the swellings, dressing the sores, or less directly through washing the clothes.

The predisposition to anthrax appears to be less in man than in the herbivora, yet a direct inoculation on one who has not already suffered is usually infecting. Following its animal origin, the greater number of cases occur in the summer and autumn. In man, as in animals, the presence of a small quantity of lactic acid greatly enhances the

virulence of the bacillus; hence the predisposition is increased by severe muscular exertion with the increased production of sarcolactic acid.

Pathological Anatomy.—This is essentially the same as in the animal. The bacillus induces a local non-suppurative inflammation, with rapid accumulation of leucocytes, blocking of the capillaries with dark non-aërated, distorted blood globules and bacilli, more or less abundant exudation of a gelatinous and bloody fluid, and the supervention of

Fig. 59.



Malignant pustule: *A*, Central eschar; *B*, vesicular areola; *C*, peripheral infiltration; *D*, œdematous skin (from Charcot).

coagulation necrosis. There is the same enlargement of the spleen, congestion of the liver, venous condition of the blood, rise of temperature and pulse, the same capillary embolism and minute extravasations in all parts of the body—the same cyanosis, oppressed breathing, coma, and death. There is the same black, tarry, comparatively incoagulable blood and an unusual tendency to hypostatic discoloration. The cutaneous and pulmonary forms demand a special notice.

In *malignant carbuncle* (*pustule*) there is the central congested papule with its blocked capillaries giving a peculiar dark red shade to the lesion, or later there is a mass of necrotic tissue of the same dark color and covered by a black eschar. Around this are more recent papules and vesicles with blood-stained contents and a firm base of embolic capillaries, multiplying leucocytes, and blood extravasations. Around this is an œdematous and phlegmonous infiltration of the skin and subjacent structures. On section the necrotic or phlegmonous nodule is seen to extend deeply into the subcutaneous connective tissue with softer blood-stained extensions in different directions. Later there are the concurrent lesions of general infection.

In *anthrax œdema* there is a diffuse phlegmonous inflammation without any central nodule. Capillary embolisms and minute blood extravasation are present, but are overshadowed by the abundant œdematous swelling in the loose connective tissue. The rapidity with which it spreads and becomes fatally generalized renders the occurrence of open sores a rare condition. It has been seen especially in the eyelids, the neck, and the forearm, where the connective tissue is abundant and loose and poorly supplied with bloodvessels.

In *pulmonary anthrax* there is intense congestion of the lungs with numerous minute blood extravasations into the parenchyma, bronchi, and alveoli, with similar phlegmonous enlargement and blood-staining of the bronchial, mediastinal, and inferior cervical glands. By his experiments in causing guinea-pigs to inhale the spores in steam, Buchner showed that the bacillus first propagated itself in the smaller bronchi and air cells, and made its way through the epithelial cells by process of growth before the lung tissue and blood became infected. Blood-stained exudations into the pleura and pericardium are usually present. Pulmonary anthrax becomes rapidly generalized; hence all the concurrent lesions of that form are met with. As in all other forms of the disease, the presence of the bacillus in the blocked vessels and exudate is characteristic. In the tissues the bacilli are rarely uniformly diffused, but aggregated in groups or felted masses. Apart from the primary seat of infection, the lymphatic glands usually contain them in the greatest numbers.

Symptoms.—*Malignant Carbuncle* (*Pustule*).—Usually a few days after exposure to the infecting material the patient notices a burning and itching, and soon there appears a slight, hard, papular elevation like a fleabite, but with a very dark red centre, on which a small vesicle later appears. In twenty-four or forty-eight hours this has increased to half an inch in diameter, is firm, tender, and painful, and the centre which has burst or been opened by scratching is gangrenous, brownish red or greenish black. This is surrounded by a swollen red or violet areola, shading off into blue or yellow, and, if the disease continues to extend, by a circle of new vesicles from a hempseed to a pea in size, which pass through the same transformations. An œdematous engorgement extends from the centre, sometimes limited and sometimes including the entire arm or head and neck, and there is distinct enlargement and tenderness of the adjacent lymphatic glands. There is always more or less constitutional disturbance, headache, pains in the back and limbs, weariness, nausea, and, in bad or neglected cases, generalized anthrax supervenes.

In milder cases the slough is separated in connection with the process of suppuration, the sore granulates, and the surrounding swelling and general symptoms subside.

Apart from the virulence of the infecting material, certain conditions have much influence in determining the result. The dense and vascular tissues of the derma favor an active inflammation and a liberal production of leucocytes, which contest the field with the bacilli hemmed in by the dense inflamed tissue around. Then the introduction of the pus microbes further antagonizes the bacillus anthracis, and if free suppuration is established a favorable tissue may be expected. On the other hand, if the sore remains dry and the infiltration extends rapidly in the connective tissue and lymphatic glands, an unfavorable result may be dreaded. Yet for the first forty-eight or sixty hours the disease is in the main local, and vigorous local treatment may be expected to succeed.

Anthrax Œdema.—Appearing in loose and comparatively non-vascular connective tissue, as in the eyelids, neck, or forearm, this shows the phlegmonous œdema, without at first much increase in the vascularity

of the skin, and without the papule, vesicle, and sloughing nodule. Not being circumscribed by firm inflamed walls and rapidly multiplying leucocytes, it extends with great rapidity and tends to early general infection. In the milder cases, however, recovery may ensue, and in some instances vesicles and gangrenous sores may appear.

Anthracæmia.—As in animals, internal anthrax may go on to an early death without any distinct symptoms of localization. There is a sense of depression and weariness, restlessness, insomnia, pains in back and limbs, and even cold perspiration. With or without these premonitory symptoms there follow chilliness or rigor, nausea, vomiting, headache, great prostration, profound mental depression and anxiety, coldness or numbness of the limbs, difficult breathing, stupor, coma, and death in forty-eight hours or in three days. A dusky or cyanotic condition of the skin and mucous membranes, and the appearance of blood in the urine or stools or in the nose or eyes, may further identify the affection.

Intestinal Anthrax.—After eating diseased flesh, sometimes as early as after eight hours and at other times after twenty-four or forty-eight, the patient is affected with chilliness or rigor, abdominal pain, nausea, vomiting, bloody diarrhœa, headache, extreme prostration and weakness, restlessness, difficult breathing, and, in from one to three days, stupor, coma, cyanosis, dyspnœa, and death. Bleeding from the pharynx or mouth is further characteristic. Glandular swelling of the neck with infiltration of the connective tissue may also be present. The pulse is small and rapid, and the temperature only slightly elevated. External localization may accompany this, and in some cases in which the abdominal symptoms have been comparatively slight and prolonged, an extensive external anthrax may later become the most prominent feature.

Pulmonary Anthrax (Wool-sorter's Disease).—In this the chest symptoms predominate. There are usually the same general sense of malaise, depression, weakness, chilliness, with headache, nausea, and perhaps vomiting. On auscultation there may be rhonchi and patches of crepitation. There is an oppression of the breathing altogether disproportionate to the appreciable lesions. There is also marked flushing of the face amounting perhaps to cyanosis. Cough is present, but not violent. Sore throat and swelling of the cervical glands may be present. The prostration becomes extreme, stupor or delirium supervenes, with dyspnœa, cyanosis, collapse, and death in from twelve hours to two or even five days. These cases are generally fatal, and though they may remit, they as constantly relapse. The occupation of the patient, the rapidity of the onset, the early extreme prostration and exhaustion, the stupor, delirium, cyanosis and collapse serve to identify the disease. The swelling of the throat and neck, and the bleeding from the pharynx and kidneys may also serve for diagnosis.

Diagnosis.—This must always be made in case of difficulty by a microscopic determination of the bacillus with its characteristic large size, immobility, and square ends, and, if need be, by inoculation of a rabbit or mouse, which in anthrax will die with the characteristic symptoms in two days. The bacillus may be sought in the vesicle, the sloughing indurated centre, the œdematous swelling, or the bloody expectoration, urine, or stool.

Prophylaxis.—In addition to the radical measures laid down for animals, the following points are important: Persons with sores on the hands, hangnails, etc. should on no account handle animals or men suffering from anthrax or their products. If this has been done inadvertently, the sores should at once be cauterized with silver nitrate and dressed with carbolic acid (1 : 300). Workers in tanneries should avoid letting the hides come in contact with face, neck, or shoulder, and should wash the hands frequently in a solution of mercuric chloride or carbolic acid when handling suspected specimens. Wools, hairs, etc. from anthrax localities should be laid loosely in a room with steam until damp throughout, and then subjected to strong fumes of burning sulphur for twelve hours. Those who handle the articles prior to disinfection should wear respirators of cotton wool which may be disinfected by heat. The sale of anthrax hides, wool, etc. should be interdicted unless they have undergone a thorough disinfection under official supervision. Marketing the flesh or dairy products of even mild cases of anthrax should be forbidden by law, and guarded against by the strictest inspection in stock yards, in municipal abattoirs, etc. A diffusion of information as to the nature and danger of anthrax is a most essential precaution, and in anthrax districts and in factories likely to use anthrax products antiseptics such as carbolic acid solutions should be always at hand.

Treatment.—The most essential thing in external anthrax is the thorough destruction of the local affection. In the initial stage with only the dark red spot or papule the complete destruction of this with a red-hot needle is effective. In more advanced cases with a hard nodule and œdema the surface may be sponged with a 10 per cent. solution of carbolic acid, and the hard part excised with as much of the surrounding œdema as can be safely reached. The wound may then be filled with surgical cotton soaked in the same solution and the skin brushed over with the same lotion. In the more advanced cases and in anthrax œdema so extensive as to forbid complete excision the whole affected area must be filled with the carbolic injection by means of a hypodermic syringe passed into all parts in succession and emptied as it is being withdrawn. The surface may be covered with cloths wet in mercuric chloride solution (1 : 500) and by an ice bag. Enlarged lymphatic glands may be excised and the wound treated with the carbolic acid lotion. If the edges of a wound continue to rise, a thorough cauterization should be repeated.

In internal or general infection resort is had to quinine 10 grains and carbolic acid 7 grains four times a day; to large and frequent doses of tincture of muriate of iron, 20 drops every four hours; and to stimulants. In the earliest stages attention should be directed toward local destruction of the bacillus. If anthrax flesh has been eaten, an active emetic may be followed by carbolic acid and perhaps pyoktanin; in cases of inhaled spores the breathing of carbolic acid and fumes of burning sulphur will be especially indicated.

Finally, a resort may be had to one or other of the bacteria that have been so successful experimentally in the lower animals. A pure culture of the pneumococcus of Friedländer, the bacillus pyocyaneus, or of the

staphylococcus pyogenes aureus, thoroughly sterilized by heat and injected subcutaneously (and in intestinal anthrax swallowed), may assist materially in arresting the disease. Similar injections might be made into the peritoneum in intestinal anthrax, into the trachea and pleuræ in the pulmonary form, and into the œdematous swelling in the external.

RABIES.

By JAMES LAW, F. R. C. V. S.

Synonyms.—Hydrophobia; Canine madness.

Definition.—Rabies is an acute febrile disease, propagated by inoculation only, and characterized by a prolonged incubation, followed by an access of fever and of nervous disorders of a characteristic type. The habits become unnatural and depraved, the temper irritable and uncontrollable, reflex excitability extremely exaggerated, visual illusions and hallucinations are developed, and spasms and paralyses of the muscles set in. If neglected it is almost invariably fatal.

Animals Susceptible.—The disease is most common in the canine races (dogs, wolves, foxes, jackals, hyenas, etc.) and in felines (cats, lions), partly because of innate susceptibility, and largely because of their tendency to bite and get bitten and inoculated. Warm-blooded animals, however, appear to be universally susceptible or nearly so—cattle, sheep, goats, deer, horses, asses, mules, badgers, apes, rabbits, rats, mice, chickens, pigeons, etc. furnishing victims. Skunks not only suffer, but from their fearlessness and disposition to bite on the sly are very effective as propagators of the infection. Man suffers from the bites of mad dogs, cats, and, less frequently, from wolves and skunks. All genera are not equally susceptible, and some, like apes, hens, and sheep, reduce the potency of the virus passed through them.

Etiology.—There is only one cause—namely, inoculation from an animal suffering from the disease. It may be assumed that the virulent principle is an organized germ, but so far all attempts to isolate and cultivate it in a pure culture have manifestly failed. Pasteur and Fol found in the nerve centres of rabid dogs micrococci 0.02μ in diameter and often joined in pairs. Rivolta found streptococci of four or five elements, and Babes found a coccus 0.5μ to 0.8μ, which he cultivated in blood serum or gelatinized bouillon at 37° C., and inoculated in the brain successfully in some cases, but mostly without success. After the second or third generation it proved non-pathogenic. Dowdeswell, Mottet, and Protopopoff have also investigated the subject, but, though the last two claim to have produced typical rabies by their cultures, the microbe cannot yet be certainly identified.

All indications, however, show that the *materies morbi* is a microbe. The inoculation of the smallest particle of virulent saliva or brain matter produces a fatal general disorder in which the infection is multiplied and pervades all organs and liquids of the body. The long period of incubation is incompatible with poisoning by a chemical agent, which would operate promptly if at all, and be eliminated long before the rabies sets in. Rabies agrees with all other germ diseases in developing

only after inoculation, in that one attack usually protects against a second, and that it never appears for the first time in a country from which mad dogs are excluded (Australia, Tasmania, New Zealand, St. Helena, South Africa, West Africa, the Hebrides, the Azores), whilst it does continue and become permanent in localities previously free, but into which infected dogs have been brought (Buenos Ayres, Malta, Hong-Kong).

In spite of popular prejudice, abuse, neglect, privation, and season have no effect in generating rabies, though they may increase susceptibility. It is probably hopeless to eradicate the dread of the dog star and the dog days, but statistics show a steady rise of cases of rabies in early spring, before the advent of the hot summer months. Thus, Bouley had 755 cases in December, January, and February, 857 in March, April, and May, 788 in June, July, and August, and 696 in September, October, and November. The real explanation of the extra prevalence in spring and early summer is found in the fact that the bitches rut in spring, and the numerous candidates for their favors bite each other fatally. This is aggravated by the fact that the generative instinct is stimulated in the early stages of rabies, so that any developing cases are likely to follow a rutting bitch. This further explains the predominance of rabies in males (1746 males to 244 females), the irritable rabid dog antagonizing his male competitors and respecting the female object of their common desire. The suppression of the generative desire, invoked as causing *rabies de novo*, only develops it in infected countries and in animals already bearing the germ, never in countries where rabies did not previously exist. The excitement will hasten the eruption in the inoculated animal, but will never develop the disease *de novo*. The bite of the dog in a violent passion or under any other form of excitement is not rabific unless he has himself been bitten and is mad. The same is true of the skunk. Its teeth may be infected from eating carrion and produce septicæmia, but, unless in limited districts where skunks have been infected with rabies, the bite will not prove rabific.

Broad generalizations show the impossibility of spontaneous cases of rabies. The absence of the disease in islands in the Elbe while rabies was epizoötic on both banks; its absence for centuries from the Hebrides and Malta, each with its special breed of dogs, though constantly present on the mainland; and its prompt disappearance from Berlin, Eldena, and other cities when all dogs were strictly muzzled,—sufficiently prove the absence of any cause save infection. What never occurred in the past need not to be looked for in future. Cases in which infection is denied because the dog was shut up will be explained by a more thorough investigation. Rabid dogs will leap high fences to reach a supposed enemy, and rabid rats and other vermin enter through small holes.

Rabies like most microbian diseases is at first confined to the region of the bite, and the tissues there alone are infecting. When fully developed the infection is resident in the blood and all vascular tissues, yet the usual source of infection is through the bronchial mucus and the saliva, both of which are especially virulent and are naturally implanted by the teeth. This virulence is not confined to carnivora, but has been experimentally demonstrated in omnivora and herbivora as well, and

may be inferred for birds. Various cases of infection from man to man are on record. Drying of the saliva or blood apart from heat or putrefaction does not destroy its virulence, and knives fouled on rabid animals have been used for successful inoculation months and years later.

Among other methods of infection besides the bite may be named the licking of a sore by a dog in the early stages of rabies and the occupation of kennels or stalls that have previously harbored rabid animals. Rabies has been known to attack a second pack of hounds after the first pack had been killed out because of the disease, and the only way to prevent this is by a thorough disinfection or destruction of the kennels. The mangers and feeding dishes charged with expectoration and saliva are pre-eminently dangerous. In one case a man was infected by using his teeth to untie a knot in a rope that had been used to tie a mad dog.

Infection in man has been caused by a bite from a dog that had been previously fighting a rabid dog, and again from the scratch of a cat that had been licking its claws. Again, as recoveries are not unknown (though very rare), and as dogs may be immunized by inoculation, it follows that a dog may communicate the disease without itself showing any symptom. In some cases of incipient rabies in dogs the saliva has been virulent before any outward symptoms were shown; hence all dogs, however sound in appearance, are objects of suspicion in an infected district.

Bollinger suggests the possibility of infection by fleas and lice which have lived on the rabid dog and sucked its blood.

No case of infection through milk or semen has been proved. The percentage of those bitten by rabid animals that contract rabies is greater in animals than in man, because the bites in man are mainly made through clothing, which cleans the teeth from the virus before they reach the skin. Even in man this distinction holds, since the bites of wolves and hounds, that fly at the face and throat, are far more fatal than those of dogs on the clothed parts of the body. Bites on the face, too, as being nearer to the brain, the seat of the election of the affection, produce the disease earlier and with greater certainty. Bouley found that 90 per cent. suffered after bites on the face, 63 per cent. after bites on the hands, 24 per cent. after bites on the arms, 7 per cent. after bites on the legs, and 63 per cent. after (mostly multiple) bites on the body. Of dogs 49.7 per cent. suffered, of cattle 61.6 per cent., and of sheep 42 per cent. The susceptibility of sheep is known to be slight, and the teeth are more likely to be cleansed on their wool. Much, however, depends on the stage of the disease and the abundance and virulence of the virus in the saliva as well as upon the susceptibility of the subject. Some are insusceptible either naturally or by reason of their having been previously subjected to the products of the germ, yet under a full virulent dose nearly all succumb.

PATHOLOGICAL ANATOMY.—The macroscopic lesions of rabies are somewhat obscure. Taken, however, with the microscopic appearances and the symptoms shown in life, identification of the disease is not usually difficult.

In *animals* there is emaciation, mucus about the eyes, mouth, nostril,

and prepuce, staring coat, venous congestion, and livid mucosæ. The tongue has a dirty brown fur, the pharynx is often red and congested ; in cattle I have seen the vocal cords ulcerated. In the dog foreign bodies, such as straws, hairs, pieces of wood or clothing, may be found in the mouth or pharynx. The pharyngeal lymphatic glands are usually dark from blood engorgement and extravasation. The salivary glands are grayish red and collections of lymphoid cells may be found around their follicles. The gullet contains grayish tenacious mucus and sometimes traces of foreign bodies. The stomach is congested and contracted. In the dog it contains no food, but a mixture of foreign bodies and indigestible substances which are highly characteristic of the disease—hair, straw, wood, coal, bits of leather, cloth, dirt, grass, and stones, bespeaking the depraved appetite during life. The mucosa is brownish red or deeply congested in parts, with petechiæ and even ulcers. A yellow viscid mucus covers it at points. The small and sometimes the large intestine, with little or no ingesta, may contain masses of foreign bodies and bile-stained mucus. The liver is congested with a black tarry blood, and its cells are the seat of granular degeneration. The mediastinal glands are congested, the kidneys hyperæmic, and the bladder contracted and empty or holding only a little yellow, turbid, albuminous urine. The bronchia may be slightly congested and occasionally enclose foreign bodies, and the lungs are the seat of venous congestion, but of no other marked change.

On removal of the calvarium the cerebral meninges are found hyperæmic, the sinuses gorged with dark blood, with minute extravasations and thickening of the membranes due to interstitial fibrinous exudate and cell production. The epithelium of the central cerebro-spinal canal may be increased, and at points broken down and replaced by blood or granular or hyaline masses. In the gray matter around and on the floor of the canal may be found minute hemorrhages, which under the microscope are found to correspond to thrombosis of a capillary with leucocytes or a hyaline pigmented mass. Such points found in the gray matter of the spinal cord and bulb and in connection with the motor centres are characterized by the accumulation of lymphoid cells in all the coats of the vessels and in the perivascular lymph space, along with granular and hyaline matter. Babes and Mikailescu further describe changes in the nerve cells, with cloudiness of the protoplasm, with vacuoles, and in the nucleus karyokinesis. These have been especially noticed in connection with the motor centres in the medulla oblongata and spinalis, but also in the gray matter of the cerebrum. The nervous trunks, too, may be the seat of congestion and the fibres undergoing granular degeneration. In one case Eichhorn found the nerve filaments in the seat of the infection wound materially thickened and indurated. This, however, like the occasional redness and congestion in the seat of the cicatrix, is by no means constant. Indications point to the conclusion that the infection extends from the infection wound largely along the nerves. There is the long period of incubation, longer when the bites are in the lower limbs, shorter for the arms, and still shorter for the head ; there is the special virulence of the nerves, said to be highest in those of the bitten member (Bardach); and there is the assertion that after inoculation in the sciatic nerve the infectiousness of the spinal cord

is found to progress gradually from behind forward (Di Vestra and Zagari). Why paralysis should not develop in the nerves first affected, before the cerebral symptoms set in, does not appear.

The lesions to be specially relied on in both man and animals are the congestion in the fauces and throat, the congested, infiltrated, or ulcerated state of the stomach, the absence of food, but the presence in the dog of foreign bodies and in man of mucus and a débris like coffee-grounds, some congestion of the small intestines, of liver and kidneys, an empty or nearly empty bladder with congested mucosa, mucous or muco-purulent oozing from the various mucous openings, venous congestion and infarctions of the lungs, a black, tarry blood, congestion of the superficial veins, and the congestion of the brain and meninges, with capillary embolisms and minute centres of trophic change. These, with the history of the case, are usually sufficient to identify the disease. It should be added, however, that in the paralytic and lethargic forms in the dog there may be an entire absence of foreign bodies in the stomach.

SYMPTOMS.—*In the Dog.—Incubation* in case of inoculation with potent virus on the brain is six days; in other parts it varies from sixteen to two hundred and forty, with an average of twenty-five days.

Prodromata, which last one to three days, consist in some marked change of habits, with usually restlessness, frequent changing of position, sullenness, and irascibility. In other cases the dogs are more confiding and fawning and liable to infect by licking their master or others. There may be dulness and apathy, but more frequently there is a hyperæsthesia, the dog starting at the slightest noise and crouching as in fear. A tendency to pick up and swallow foreign bodies, like hair, straws, thread, paper, pins, pebbles, dung, dirt, etc., is highly characteristic excepting in puppies, which do this in mere wantonness. The victims eagerly lick cold smooth objects, as stones, metal, boots, or the nose or genitals of another dog. Sexual excitement and manifest desire for coition are marked. Sudden passion when shown another dog or a cat, sudden starting and jumping toward the door, a seeking of darkness and seclusion, and a disposition to leave home and wander away many miles are most significant. The dog will shrink from a blow, yet bear it without whine, and yet will bark or howl without cause when alone; the sound is a hoarse, low, muffled one, beginning as a bark and prolonged into a howl, and repeated two or three times in lower tone without closing the mouth. He may tear wood or clothes to pieces, may rub the chops with his paws as if something were in the mouth, may turn the eyes and head as if following some object, and presently snap at it; he may vomit a bloody material, and he may lick or even gnaw the inoculation wound, which is now liable to become congested, though cicatrized weeks before. The conjunctivæ are reddened and the skin of the face drawn into wrinkles. These premonitory symptoms are the most important ones, since, if they are recognized, the animal may be shut up before he can do any injury to man.

In its subsequent course the malady divides itself into three typical forms—the *furious*, the *paralytic*, and the *lethargic*. The first of these is most common in the less domesticated dogs, while the latter are seen especially in house and pet dogs.

The *furious form* is shown by paroxysms of violence, during which

the animal attempts to escape, gnawing at his chain or the doorposts, howling more frequently, trying to bite any creature that annoys him, and even showing a mischievous disposition to attack without provocation. Former human or animal friends are no longer respected, though at first a reluctant obedience may be given to a loved master. If free, the animal may wander off ten or twenty miles, attacking any one in his way, especially if he makes noise or disturbance, swimming rivers, for he has no dread of water, and after the paroxysm he may return home, fawning upon, licking, or even suddenly biting his friends. In this remission he seeks quiet, seclusion, and darkness, until a second paroxysm rouses him to violent effort. But he may be roused at any moment by threatening him with stick or whip, and above all by presenting to him another dog or cat. In such cases he may tear at a stick or iron bar until his teeth are dislocated and the gums bleed freely. He will even at times bite himself, tearing hair or skin from fore limbs or shoulders, and gnawing the tail, toes, or other part of the body. Food is rejected, or if swallowed may be vomited. The eyes squint or the dilated pupils give them a peculiar staring appearance as they follow imaginary objects.

Twitchings of the muscles of the face or general convulsions may come on. In two or three days the power of the hind limbs is gradually lost, the hind parts first swaying unsteadily, and finally resting helpless upon the ground, while the animal still raises himself on his fore limbs. The jaw drops from paralysis, saliva drivels from the mouth, and there is no longer danger of biting. Gradually the paralysis extends to the whole body, and unless interrupted by convulsions this lasts until death on the sixth or eighth (exceptionally the tenth day) from the first symptoms.

In *paralytic* (*dumb*) *rabies* the paralytic stage supervenes at once on the prodromata. The symptoms therefore are essentially those of the culminating stage of the furious form.

In *lethargic rabies* there is neither fury nor at first paralysis, but the animal after the prodromata passes into a condition of lethargy, and remains curled up in a corner, not to be disturbed by threats, punishment, or coaxing; food and drink are alike refused, and the animal drowses along until relieved by death from the tenth to the fifteenth day.

Besides these three forms there are all intervening grades in which one or other of the specific types tends to predominate.

In other Carnivora.—*Wolves*, *foxes*, *jackals*, and *badgers*, overcoming their natural fear, enter villages and cities and bite men and animals after the fashion of the rabid dog. Wolves are especially dangerous because of their strength and ferocity and their disposition to seize on the uncovered throat and face. *Rabid cats* are more retiring, yet easily roused to violence, and use teeth and claws indiscriminately, producing infecting wounds with both. The voice is altered and hoarse, like that made in rut. In all these animals, as in the dog, the violent symptoms merge into the paralytic prior to death.

Symptoms in Man.—*Incubation* is said to be extremely variable in man. In 6 per cent. of all cases it is between three and eighteen days, in 64 per cent. it is between eighteen and sixty-four days, while in 34 per cent. it exceeds sixty days. From fourteen days to two or

three months may be said to be the limits. Recorded cases of incubation extending from one to seven years cannot be accepted without the evidence of successful inoculation upon an animal. So frequent in man are cases induced by an overworked imagination (*lyssophobia*) that the very short and very long incubations are to be suspected of belonging to this category until they shall be proved genuine by inoculation on an animal, in which the explanation of a too vivid imagination is inadmissible. No such protracted incubation is met with in any of the lower animals.

At the conclusion of the latent stage the first symptom is usually an itching, pricking, or pain in the seat of the infection wound, which, though completely healed over, now again becomes congested or swollen. Touching the scar may produce an aura extending toward the body, sighing, or tremor. There may be chilliness, headache, weariness, depression, sullenness, irritability, irascibility, and ungovernable restlessness which impels to constant or frequent movement. There is insomnia or broken sleep with frightful dreams, increasing mental anxiety, sensitiveness even to a current of cold air, and much more to sudden flashes of sunshine, noises, and movements. A tendency to spasms in the throat is shown in increasingly difficult jerking articulations, and some difficulty in swallowing liquids which cause a sense of fulness of the throat and dread of water. The fauces and pharynx are now congested and reddened, as are also the eyes and usually the face. The pulse is somewhat accelerated and hard, but usually small. Breathing is oppressed and accompanied by sighing or sobbing. The mind is clear.

In some cases the malady sets in at once in full severity. The patient is suddenly and unexpectedly seized with spasms of the throat and chest, usually when attempting to drink or when abruptly startled. These are so violent that for the time they threaten suffocation, and from that time on the dread of water is extreme. The sight of a liquid, the sound of it dropping or flowing, the offer of drink, the sight of a smooth surface like glass, will bring on a violent paroxysm. There is not only the feeling of impending suffocation, but a sense of rising of the stomach, with actual retching and vomiting, and a convulsive cough or scream which has been likened to a bark. In the absence of drink a paroxysm may come on in which the predominant sensation is the oppression about the chest and stomach. In all such attacks the face is red, drawn, and distorted, the nostrils and pupils dilated, eyes projected and reddened, and the expression agonized. There are tremors and convulsive contractions of the muscles of the limbs and trunk. The hyperæsthesia is intense, the senses become painfully acute, a bright light, a sound, even of talking, or a slight touch being intolerable. Even in the intervals this continues, and, unless all exciting sights, sounds, or touches can be obviated, another paroxysm is precipitated. The tendency is, however, to a progressive increase of the violence of the paroxysms and decrease in the duration of the intervals, until the patient becomes worn out.

A remarkable and dangerous feature, which like dread of water is peculiar to man, is the spitting out on all sides of the saliva, which can no longer be swallowed. For a length of time the mind is clear, but at

the height of the disease the paroxysms merge into fits of mania. The patient charges those about him with having caused his sufferings, and assaults with hands, feet, or teeth any one who approaches. Restraint aggravates this and prolongs the attack. When the paroxysms subside, reason resumes its throne, and the patient is profuse with regrets, apologies, and warnings for the future. Death often takes place from asphyxia or apoplexy during a paroxysm, and at times suddenly after symptoms of material improvement. The paroxysms vary in length from a half to one hour, and the intervals from a few minutes to several hours. Paroxysms are more violent in the strong and vigorous, in men than in women and children.

Should the patient survive the violent stage, paralysis sets in. The spasms become feebler and finally cease, the breathing is relieved, the hyperæsthesia lessened, and deglutition may again become possible. But debility and prostration increase, twitching of the muscles is seen, the lower jaw drops and saliva flows from the mouth. The breathing becomes rapid and rattling, the voice weak and harsh, the pulse small, rapid, and irregular; stupor comes on and death ensues, preceded by a state of coma. In exceptional cases the paroxysmal stage is almost or altogether omitted.

The entire duration of the disease in man is from two to four days, exceptional cases being less or more.

Diagnosis.—The diagnosis of the disease is not usually difficult if one finds the history of a bite, the recently healed wound, the intense hyperæsthesia which serves to distinguish it from mania, spasmodic sore throat, epilepsy, and hysteria, and the absence of trismus, which distinguishes it from tetanus. The greatest difficulty is with cases of *lyssophobia*, but in these, as in hysteria, the patient usually fails from imperfect acquaintance with the essential symptoms, and cannot get up artificially that extraordinary hyperæsthesia which is so pathognomonic of hydrophobia. Moreover, in nearly all these cases investigation will show a flaw in the history: the animal that bit may be still alive or its death may be uncertain, or it may have been killed by an excited community, or the incubation may have been too short or too long to admit the probability of hydrophobia. An investigation of this history is always in order, and unless there have been cases of rabies in the lower animals from bites made by the animal suspected, it may be opined that the human patient is a victim of *lyssophobia* and to be cured by moral suasion alone.

Prophylaxis of Rabies and Hydrophobia.—The evidence is overwhelming that rabies is always the result of inoculation from a rabid animal or a hydrophobic man; therefore it is not only possible, but a duty incumbent on every country, to stamp the disease out of existence. Each state should enact and rigorously enforce a law with measures like the following: 1. Register all dogs and tax them heavily; 2. Have every dog wear a collar bearing a plate inscribed with its owner's name and residence; let all dogs appearing without such badge be summarily shot by the police or constables; 3. Let every dog be muzzled in cities and counties that have furnished cases of rabies within a year, and in adjoining counties; let all dogs found at large unmuzzled be at once shot by the police; 4. Dogs and cats bitten or supposed to have been

bitten by rabid animals must be promptly killed or shut up in iron cages for six months under veterinary supervision; 5. Dogs or cats which have bitten men and are believed to be rabid should not be killed, but shut up in iron cages under veterinary supervision; if they do not develop rabies, it will be easy by the sight of the healthy animal to protect the the bitten person against *lyssophobia;* 6. Dogs imported from countries other than those from which rabies is excluded (Australasia, etc.) must be subjected to a quarantine of six months before they can be set at liberty; 7. Foxes, wolves, badgers, martins, skunks, and other vermin that use the teeth as offensive weapons must be destroyed by poison or otherwise in districts infected with rabies; 8. The disinfection of kennels and other buildings where rabid dogs or other animals have been must be carefully carried out; 9. All owners of dogs should be furnished with a circular giving the premonitory symptoms of rabies, and enjoining them to shut up and report any dog showing such symptoms.

The methods of immunizing dogs against rabies are so closely associated with the Pasteurian treatment of the bitten that they will be best considered together.

Treatment of Rabies and Hydrophobia.—The *treatment of the bite* should receive first attention. If caustics are not at hand, the first effort must be to prevent absorption of the poison. If a limb has been bitten, a cord or handkerchief may be tied round above the wound and a stick passed through it and twisted until circulation has been arrested. The wound may then be sucked either through a tube or, if the patient can reach it, with the lips, the mouth being washed frequently with carbolic acid or other antiseptic lotion. Steeping the wound in warm water and wringing it is good as a temporary resort. Drinking of liquids to excess temporarily hinders absorption. As soon as a caustic can be obtained it should be applied thoroughly to all parts of the wound. An iron skewer, nail, or poker at a white heat should be brought in contact with all parts of the wound, and, as the teeth have often met in the flesh, it is usually necessary to pass it clear through between the two external wounds. If chloride of zinc, caustic potash, nitrate of silver, or sulphate of copper or iron is the available caustic, the greatest care must be taken to apply it thoroughly to all recesses of the wound, any fibrous tissue that prevents this being cut through. If mineral acids or other liquid caustics are employed, they may be delivered in the utmost recesses through a pipette or on a pledget of cotton on a staff. When available the galvano-cautery is to be preferred. The parts should be washed with a strong solution of mercuric chloride. Not until the cauterization has been complete should the tourniquet be removed. A delay of several hours or days is no warrant for omitting cauterization. It has always a good moral effect in preventing *lyssophobia*, and as it is almost certain that part of the poison, which is for a time confined to the region of the sore, is the dangerous portion, it may still be possible to prevent the disease. Senn's advice to excise the adjacent tissues may here be followed, but not to the exclusion of a thorough disinfection. In a very badly mangled limb the only reasonable hope may be in amputation.

In the same line of prophylactic treatment after the bite is the now famous Pasteur method. Rabbits are inoculated on the brain, one from the other, until the disease develops six or seven days after inoculation,

the virus having attained to its highest potency. The rabbit infected with this potency is killed, and aseptic sections of its spinal cord are preserved *in vitro*, in free but aseptic air, dried by contact with caustic potassa, for periods varying from one to thirteen days. The virulence lessens from day to day, so that the 13th-day product can be inoculated with perfect safety. The treatment of a bitten person or dog is conducted by giving hypodermically, on the first day, four 2-gramme doses of solutions of the 13th, 12th, 11th, and 10th day cords; on the second day, four of the 10th, 9th, 8th, and 7th; on the third day, four of the 7th, 6th, 5th, and 4th; on the fourth day, two $1\frac{1}{2}$-gramme doses of the 4th and 3d; on the fifth day, two of the 3d and 2d; on the sixth day, two 2-gramme doses of the 8th and 7th; on the seventh day, two doses of the 7th and 6th; on the eighth day, two doses of the 6th and 5th; on the ninth day, two doses of the 5th and 4th; and on the tenth day, two $1\frac{1}{2}$-gramme doses of the 4th and 3d. With two intermissions, on the eleventh and seventeenth days, this is continued until the twenty-sixth day. The best evidence of its efficiency is the fact that in selected cases but 0.54 per cent. of persons bitten and so treated have contracted hydrophobia.

To immunize a healthy subject it is sufficient to give but one dose daily, beginning with the cord thirteen days old, and leaving off with that of the first day. As a remedial agent for the bitten this is unquestionably effective, and has already saved many lives. The objections to it are that it is not aimed at an extinction of the disease, which is the rational course with a pure contagium. It necessitates, on the contrary, a maintenance of the malady for the supply of material. It may also be questioned whether the use of the method, both for curative purposes and immunization, and the setting at liberty of many individuals just injected with the most potent virus known, may not introduce the risk of the conveyance of that germ to others.

Some attempts have been made to escape this last objection. In 1886, I sterilized with heat portions of the spinal cord of a man dead of hydrophobia, and making an aqueous emulsion of the same gave two rabbits three and one rabbit four hypodermic injections of a drachm each on as many successive days. I afterward inoculated them with infecting nervous substance, yet all survived for nine months, while three control rabbits inoculated with the unsterilized nervous substance died rabid.

Tizzoni and Schwarz, finding that the blood serum of an immunized rabbit sterilized a rabic spinal cord *in vitro* in five hours, tested this immunized blood serum on living animals and found that it conferred immunity in the majority of cases. This experiment aimed at securing the antitoxin from another animal, and while it might act temporarily as an immunizing agent and satisfactorily as a curative one when given in large doses, yet as it could not reproduce itself in the animal economy, it must soon be eliminated and the immunity lost. My experiment, on the contrary, aimed at the introduction of the toxic products so as to stimulate the leucocytes and perhaps other cells to a production of the defensive materials which would be continued after the ptomaïnes and toxins have been eliminated. I had already had a successful experience with this method in hog cholera, lung plague, and anthrax, and the

favorable results with rabies were therefore to be expected. All such methods, however, should be stopped when a systematic attempt is made for the extinction of the disease.

Fernandez appears to show by extensive statistics and numerous experiments that dogs bitten by vipers are proof against rabies. This would suggest the sterilized poison of vipers as a means of immunization.

All the functions of the bitten person should be maintained in a healthy condition. When possible he should be kept in ignorance of his danger and of the nature of the disease should it develop. He should be among calm, cheerful people, who will never refer to the matter nor allow the subject to see that they are any way anxious. If the matter does come up, full confidence in the protective measures adopted should be claimed. Every cause of excitement should be avoided.

When the disease has developed, the patient must be kept in perfect seclusion, quiet, and darkness and out of currents of air. Antispasmodics and nerve sedatives may be given by the rectum, hypodermically, or by inhalation to relieve the sufferings, though there is little hope of their obviating a fatal result. Agents like chloroform, chloral, and the bromides, which lessen cerebral congestion, are on that account to be preferred. As a therapeutic agent the blood serum of strongly immunized rabbits would hold out more hope than anything known, yet it is doubtful how far this can be relied upon when the disease is already developed. In undeveloped cases approaching the end of incubation this might be employed in connection with the intensive inoculation of Pasteur.

ACTINOMYCOSIS.

By JAMES LAW, F. R. C. V. S.

Definition.—A chronic infectious disease of man and animals, induced by the growth in the tissues of actinomyces (ray fungus), and usually manifested by hyperplastic swellings resembling sarcomata.

Animals Susceptible.—It occurs casually in herbivora and omnivora —cattle, swine, horses, and elephants—and in the human being, and very exceptionally in the dog. Experimentally, it has been produced in a number of genera, including rabbits, guinea-pigs, dogs, cats, sheep, and goats. It is probably a question of exposure, as the dog is easily infected, and cultures from the dog on artificial media grow with great vigor.

Etiology.—The essential cause is the implanting of the actinomyces in the tissues, hard (tooth, bone) or soft (connective tissue, muscle, parenchyma).

Among accessory causes caries and fractures of the teeth, and the exposure of raw surfaces on the gums and alveolæ in connection with the shedding of the teeth, are prominent factors. The alveolæ of the tonsils, the ducts of salivary and other glands, raw sores, wounds, running abscesses, and fistulæ afford a lodgement for the cryptogam and an opportunity for development. The germ may enter through a protoplasmic cell into the lymph spaces and form a primary focus in the lymph gland, but this is exceptional. Barley awns from their imbricated surface work their way readily into soft tissues and afford starting points for infection. Glumes of barley and other cereals, wheat bran, and other vegetable products have often been found in the tonsillar cavities, gums, etc. (Johne, Piana, Korsak), and on the tongue (Bodamer), along with the parasite. Jensen found the parasite growing on rye, and Liebmann, who inoculated it on grains, found that it started growth with the germination of the seed, and, growing with great energy, pervaded the entire plant. It must not be inferred that the actinomyces is confined to the cereals for its vegetable hosts, since it is not unknown in the cattle of North American plains, which live mainly on buffalo grass and never see grain.

The areas of special prevalence of actinomycosis are mostly low, damp, and rich in decomposing organic débris. Thus the disease may be said to be enzoötic in the fens of England (Norfolk and Lincoln, Crookshank), in the river-bottom of the Brora in Scotland (Dick), in the polders of Zealand (Jensen), in the low lands in Marienburg and Ebling near the mouth of the Vistula (Preusse), and in the rich, uncultivated steppe lands near the Volga (Mari) and Dnieper (Korsak). One farm in Peoria county, Illinois, furnished 17 cases of actinomycosis in a

herd of 80, and on a damp delta on Cayuga Lake, New York, I have found three bovine generations affected—granddam, dam, and daughter. This must be qualified by the statement that cases are more numerous in dry seasons, as they are also in winter, because in eating dry, withered fodder wounds of the mouth and throat are more common.

Youth predisposes strongly, mainly because it is the period of teething and of raw sores in the mouth, and partly because the tissues are more delicate and easily penetrated, and because more or less congestion is determined by sucking.

Thrush (most common in youth) and other forms of stomatitis open the way for infection, and in Europe cases increase greatly after an epizoötic of *foot-and-mouth disease*. In such cases the primary lesions are usually in the soft tissues (tongue, cheeks, and face), whereas in connection with diseased teeth or gums the jaws are the first to suffer.

The disease appears to have greatly increased in the herds of the Mississippi Valley of late years, the infection atria being furnished by the scratches, of the head and neck especially, by the barbed wire fences.

Actinomyces Streptothrix.—Actinomyces was found in the diseased jaws of cows, and studied by Perroncito in 1863, by Rivolta in 1868, and by Hahn in 1870. Bollinger was, however, the first to demonstrate its constant presence in the sarcomata of the jaws of cattle and to claim its etiological significance. Johne next inoculated the actinomyces from the cow into the abdominal cavities of two calves and mammæ of a cow. Ponfick produced a case of pulmonary actinomycosis by intravenous infection. In 1878, Israel reported two cases of actinomycosis in man with successful inoculation on animals. Langenbeck had, however, already in 1845 found the characteristic tufts in the pus from a carious human vertebra, and Lebert, in 1848, in the pus of a thoracic abscess.

Morphology.—As seen in the animal tissues, the actinomyces consists largely of branching filaments and of the characteristic round clusters or tufts. The latter are the most important diagnostically, as they are not really microscopical, but vary in size from a small grain of sand to a pin's head (0.1 to 0.5 mm.). They have a yellowish, often bright sulphur-yellow color, and may be calcified, hard, and gritty. Decalcified and cut in sections or broken down and stained, they are seen to consist—1st, of a dense central mass of interlacing filaments; and 2d, connecting with the latter, of an outer cortical layer of pyriform or club-shaped bodies terminating externally in rounded ends packed closely together like the seeds and pericarp of a strawberry, and continued by their attenuated inner seeds into the central mycelium. This large cluster, like a daisy head, is the rule, but it is not invariable. A filament sometimes terminates in a single club-shaped cell or divides into two, three, or more, while some will grow through a tuft and divide to form tufts some distance beyond. In the central felted mass are numerous cocci in groups or chains, and the free ends of the pyriform cortical cells may be surrounded by spherical granules (hyaline bodies), variously described as spores and degeneration products. They stain by Gram's method. If difficult to find in thick gelatinoid pus, that may be first cleared up by caustic potash.

Actinomyces is anaërobic, but grows well in the bottom of stab cul-

tures in glycerined or glucosed agar or gelatin. If accustomed to grow in free air, it loses its pathogenic quality, which may partly explain its prevalence on close, rich, waterlogged soils from which the air is excluded. In dry, porous soils the harmless aërobic habit must be much more common.

Habits of growth and pathogenic potency vary much with different conditions in artificial cultures. The tufts are often absent, yet the product inoculated on animals produces these as before. Gasperini not only obtained different forms from the same stock, but he observed that forms apparently identical under the microscope varied greatly in pathogenic power according to the conditions in which they had been cultivated. The virulence was further largely affected by the greater or lesser reaction of the animal tissues invaded.

Actinomyces differs from the streptothrix of Madura foot, in that it is cosmopolitan, is not confined to man, and it is not restricted to foot and hand, but attacks all regions progressively and indiscriminately. Its behavior in artificial cultures is also entirely different.

Pathological Anatomy.—Aside from the actinomyces with its characteristic yellow tufts, the pathological formations are like sarcomata. The parasite is chemiotactic, causing a great accumulation of embryonic and giant cells which are imbedded in a fibrous stroma of varying abundance, and determining a great diversity of consistency in different neoplasms. Some are very friable; others are as hard as gristle (holzzunge). The spherical and rodlike elements of the parasite, and even the clubs, enter the interior of leucocytes, and are sometimes carried by these to form new foci at a distance from the primary one. The disease may be cut short by the destruction of the parasite through phagocytosis, or molecular necrosis may ensue in the neoplasm, or suppuration may take place, developing an abscess in the centre, in the walls of which the actinomyces may continue to proliferate and advance. It is characteristic of the hyperplasia that it tends to invade all surrounding tissues indiscriminately, though advancing in soft tissues more rapidly, and that it only exceptionally implicates the adjacent lymphatic glands until tissue in contact with them has been involved. This serves to distinguish it from cancer, tuberculosis, and other diseases.

Actinomycosis in Man.—As already stated, Langenbeck found the actinomyces cells in 1845 in a carious vertebra of man, and Lebert in 1848 in the pus of a thoracic abscess. In 1877, Bollinger published his cases in cattle, and the following year J. Israel recorded 2 cases of actinomycosis in men, adding a third in 1879. New cases were soon recorded, and in 1882 was published Ponfick's work, *Die Actinomykose des Menschen*. Up to the present date some hundreds of cases have been recorded, including the invasion of the most varied organs of the body, though, as in cattle, a decided preference is shown for the vicinity of the teeth, the jawbone, face, and neck.

Actinomyces Hominis and Actinomyces Bovis.—In view of the pleomorphism of actinomyces and the variations caused by growth in different media or genera, it is difficult to decide upon the identity of these, yet the frequent inoculation of calves as well as rodents with the specimens obtained from man clearly shows that the human and bovine host can propagate the same parasite. As the morphology in man and the

ox is practically identical, it is useless to repeat what has been recorded above. (See page 776.)

Etiology.—In the main, man derives the disease from the same sources as the animal, yet the facts that he habitually cooks his food, and is not subject to the buccal injuries which come from the consumption of hard fibrous vegetables and raw grains, serve to protect him from the marked prevalence of the disease shown in cattle in actinomyces districts. The influence of dentition and carious teeth as etiological factors is seen in the frequency of primary actinomycosis in the jaw and face, and especially at an early age. The case of lung actinomycosis with a particle of carious tooth imbedded in the growth is equally significant. The direct action of barley awns has been frequently noticed. In Soltman's case the awn lodged in the pharynx, interfering with swallowing; then it penetrated the mucosa, causing hemorrhage; after this it made its way through the tissues, developing an actinomycotic phlegmon in its course, and was finally extracted through a fistula formed below the scapula. Buzzi records a case of actinomycosis of the neck extending from a decayed tooth and enclosing a straw beard in a cervical cavity. We may conclude that, as in animals, so in man, the germ is usually introduced through the food, air, or water.

Against infection through eating the flesh of actinomycotic animals man is largely protected—(1) by the cooking of his food; (2) by the impaired vigor with which the parasite grows when transferred directly from animal to animal. But that there is danger of such an infection cannot be ignored. The successful transference from man to animals implies the possibility of conveyance from animal to man. Certain recorded observations, indeed, have been thought to be cases of this kind. Baracz instances the transference from man to man, and Barnard from cattle to man. O'Neil records the case of a farmer who contracted actinomycosis after dressing calves suffering from a disease of the skin; Bergmann, a case affecting the orbit of a man who handled a diseased cow; Munch, the case of a man with pulmonary actinomycosis who had fed for three years an ox having this disease in the jaw; Oschner, the case of a farmer and cattle-dealer who treated his "lumpy-jaw" cattle with arsenic, and contracted actinomycosis of the antrum and facial bones, and of a second Illinois farmer who treated his Oregon pony for "lumpy jaw," and himself contracted the disease in antrum and face.

Pathological Anatomy in Man.—This does not differ essentially from what has been already described in cattle. The presence and growth of the parasite cause a local phlegmonous inflammation, with an extraordinary accumulation of embryonic and giant cells in a stroma of fibrous tissue. There is an attraction of leucocytes to the microbe, and a process of phagocytosis is established which may result in the destruction of the parasite or in necrobiosis of the tissues. If the latter, the disease goes on slowly spreading into the surrounding tissues, invading their structure rather than pushing them aside, and from this, as well as from its induration in chronic cases, it has often been mistaken for carcinoma. The actinomyces does not seem to be of itself pyogenic, and when lodged deeply in the tissues may progress for months without suppuration. When, however, the diseased focus is invaded by pyogenic bac-

teria through the primary infection wound or through the swelling reaching the surface in the course of its natural increase, the progress of the disease is thereafter more rapid, the destructive action of the pus microbes evidently paving the way for a freer growth. The gravity of the case, therefore, bears a close relation to the early occurrence of suppuration and fistula or to cutaneous ulceration. As in cattle, the disease process bears a close resemblance to that of the round-celled sarcoma, and is only to be distinguished by the presence of the actinomyces tufts with their central mycelium and periphery of clubshaped cells. In man, too, the disease tends to a chronic form, and generally remains confined to its primary focus for a length of time.

Localization and Symptoms in Man.—Infection may occur through any breach of continuity of skin or mucous membrane, and such breach may be caused by the growth of the actinomyces in a natural cavity like the alveoli of the tonsils or the ducts of glands. Primary foci, therefore, mostly appear in connection with skin or mucous membrane.

(1) *In the Skin.*—Ponfick records one case starting from the bite of a louse; Majocchi, one originating in a wound of the skin; Partsch, one following the excision of the breast in a man of sixty years: Hochenegg, one on the skin of the lower jaw following atheroma; and Kaposi, one in the right axilla. Lesser, who met with three cutaneous cases, found that scattered nodules appeared around the primary lesion, and the connection could be traced through passages corresponding in size to a lead pencil and filled with yellowish gray or reddish gray granulations, the tissues undergoing molecular destruction as these advance.

Kaposi's case began with a red spot the size of a florin, which grew to the size of a walnut, and then slowly flattened and disappeared, but not until new spots and nodules had formed around it, some as large as a pigeon's egg. The advance was slow for eleven years, when a swelling as large as an apple formed on the spine of the sixth vertebra, extended forward into the axilla, and finally ulcerated, exposing a soft fungous bleeding surface in which the tufts of actinomyces could be detected. Meanwhile nodules had appeared very generally over the trunk and lodged in the corium.

(2) *In the Teeth, Gums, and Jawbones.*—Cases are recorded in which a carious cavity or periodontal abscess without manifest swelling of the bone furnished the characteristic clubshaped cells (Israel, Partsch). From such centres the disease spreads to the cancellated tissue of the bone or periosteum, with resulting swelling of the lower, or less frequently of the upper, jaw. In such cases violent toothache sets in with swelling of the jawbone, and most commonly a fistulous opening discharging actinomycotic pus. Israel records one such case in a woman of forty-six in which the swelling, as large as a cherry, was twice laid open and the diseased granulation tissue scraped out before permanent healing was secured. In another case the disease in five months extended from the lower jaw to the level of the thyroid cartilage. When the lesion extends along the periosteum or the superposed soft tissues to the neck, it often makes increasingly rapid progress on reaching the loose connective tissue of that region. When it extends in the cancellated bone, the teeth are loosened, and often all the molars in the affected jaw are

extracted to relieve the attendant suffering. Murphy met two such cases in the Chicago Hospital, one in a woman of twenty-eight and the other in a man of eighteen. The woman had violent toothache, with swelling in the throat and difficult deglutition. These improved under poulticing, but returned with the addition of enlarged tonsil and swelling at the angle of the jaw, and a second swelling below on the side of the neck. The latter and the swelling in the tonsil were lanced, giving exit to actinomycotic pus. The removal of a carious tooth revealed a fistula leading from the alveolus to the external wound. The diseased masses were now scraped out and the cavity filled with iodoform gauze, and recovery ensued.

Senn furnishes two more cases from the Milwaukee Hospital. They had each lasted over five months, and all the molars of the jaw on the affected side had been extracted. In the first case the edentulous alveolar border of the lower jaw, from the first bicuspid backward, presented a continuous fungous mass, suppurating freely and with openings at intervals discharging actinomycotic pus from deep-seated abscesses. The cheek was enormously swollen from the angle of the mouth to the lower margin of the parotid, the swelling fading gradually into the surrounding tissues. An incision was made the whole length of the ramus of the jaw, the alveolar processes removed with forceps and chisel, any diseased surface of bone scraped, the diseased soft parts dissected out, the bone cauterized, and the wound packed with iodoform gauze. Great improvement followed, but six weeks later abscesses formed reaching from the jaw to the clavicle and scapula, numerous fistulous openings appeared, and the patient weakened and died. In the second case there was no open sore, no double infection by the introduction of pus microbes, and the patient recovered. The disease connected with the edentulous posterior alveoli of the upper jaw and the swelling of the soft parts extended from the zigoma to the lower border of the maxilla. When laid open the whole cheek seemed to be changed into granulation tissue in which the yellowish gray actinomyces tufts were found. This was thoroughly removed and the jawbone scraped and cauterized.

In a case treated by Bodamer in the German Hospital, Philadelphia, the lesions extended from the right lower maxillary bone, where he had had the three back teeth extracted, downward upon the neck and upward upon the temporal region, with the formation of fistulous openings at intervals. The case was a chronic one, the maxillary swelling, which had previously advanced and receded alternately, "coming to stay" in 1882, and the patient coming to the hospital in 1889.

The growths have a tendency to migrate, a swelling which at first shows on the gums being found later at the angle of the jaw or elsewhere. This seems to imply the death and removal of the actinomyces near the seat of infection, while the newer and more vigorous growth is advancing into new tissue.

(3) *In the Tongue.*—Hochenegg mentions a case of a cherry-sized actinomycotic swelling near the tip of the tongue infected from a carious tooth, which had apparently served as the traumatic agent as well. Henck saw a case of tongue actinomycosis with secondary lesions in the chest walls and vertebræ. Three other cases are on record—one primary, one secondary, and one metastatic.

(4) *In the Intestinal Canal and Abdomen.*—Primary actinomycosis of stomach or bowels occurs from the ingestion of the actinomyces with food or water. Getting imbedded in an abrasion, gland duct, or in the alveoli of the solitary or agminated glands, the parasite grows and advances into the mucosa and deeper parts. Osler records a case affecting the small intestine; Kopfstein and Lanz, cases in the ileo-cæcal region; Redtenbacher, Chiari, and others furnish additional cases. In Redtenbacher's case a young woman had a swelling like the fist in the epigastrium, and the mesogastrium firmly attached to the abdominal walls, and with a second apple-like mass felt behind. It grew rapidly from its first appearance in early summer and proved fatal in autumn. A fistula from the intestine extended into the muscles and subcutaneous connective tissue; Douglas's pouch was full of pus; and the ovaries, Fallopian tubes, and uterus were implicated. Chiari's patient was an emaciated man of thirty-six. At the necropsy was found chronic tuberculosis of the lungs and ileum. The mucosa of the cæcum and colon was catarrhal, with numerous firm round or oblong patches 1 centimetre in diameter by 5 millimetres thick, and containing yellowish actinomyces tufts. Zemann furnishes four cases of perforation of the walls of the intestines and formation of extensive abscesses in the peritoneal cavity, communicating with fistulous openings in the abdominal walls. These cases were characterized by acute abdominal pains and great tenderness of the abdomen. Leuning and Hamm furnish a case of primary actinomycosis of the colon and secondary formations in the liver, and Langhans one affecting primarily the vermiform appendix, but extending to the bladder and liver.

The *liver* is usually affected secondarily to other abdominal organs. In one case of Sharkey and Ocland, however, it appeared to be the primary seat of disease. The patient, a joiner, thirty years old, was very pallid and emaciated, and a painful tumor like an orange projected forward in the right hypochondrium. This with a similar tumor in the right loin was successively incised, evacuating a very little pus and blood, but the patient continued to sink and died on the seventieth day. At the necropsy were found the two abscesses communicating with the incision, but considerably diminished. The liver, five pounds three and a half ounces in weight, contained numerous globular actinomycotic masses, between which the hepatic tissue was soft, white, and shreddy. The left lobe was adherent to the abdominal walls and communicated with the upper incised tumor and fistula.

Mr. Shattuck gives two museum cases in which the actinomycotic abscesses in the liver were associated with adhesions and thickening of the omentum and pelvic peritoneum in one case, and in the other with tumors of the ovaries, Fallopian tubes, and adjacent parts. The latter case had invaded the right pleura through the diaphragm, to which the liver was attached.

Knur reports the case of a man of thirty who had worked in the Union Stock Yards, New York. Later he began to cough, lost strength and vigor, and had pains in the right side. A swelling formed in the right hypochondrium, which was lanced, but yielded only a bloody liquid débris. Similar swellings followed at intervals, but their incision gave no better results, and the patient became very pale, emaciated,

and weak. In the discharges were found actinomyces tufts, and an operation was attempted, but the patient died of shock.

A case involving ovaries and liver is reported by Stewart and Muir, and one affecting the liver and lungs by Taylor. Cases involving the urinary organs are reported by Langhans and Ransom.

(5) *In the Chest and Air-passages.*—Majocchi saw a case in which the mouth and larynx were simultaneously affected. Actinomycosis of the lungs has been frequently observed, the germ having been evidently inhaled. In one case, however, Israel found a fragment of an infected carious tooth in the centre of the lung lesion. The diagnosis may be made by observing the actinomyces tufts or clubs in the expectoration in cases affecting the bronchial mucosa and attended by symptoms of fœtid bronchitis, and also in extensive deposits in the lung tissue and cavities communicating with the bronchia. The actinomyces must not be confounded with cells and mycelia of leptothrix or aspergillus. In other cases with adhesions of the lung and the formation of a fistula through an intercostal space the discharge may identify it. In those forms, however, in which there are miliary deposits only in the lung tissue it may be impossible to diagnose it from tuberculosis excepting by a resort to tuberculin as a means of inducing reaction. In most cases, however, pulmonary actinomycosis is associated with lesions in other organs, which materially help in diagnosis. Fever, though usually present, is variable according to the extent and activity of the inflammatory action and the invasion of pyogenic microbes.

Primary actinomycosis of the lungs is recorded by Munch (1 case), Canalie (1 case), Ullmann (1 case), Hanan (2 cases), and Jekenovitsch (1 case). Netter furnishes 2 cases, of the pleura and posterior mediastinal glands respectively, in both of which the lungs were sound. In other cases the vertebræ and walls of the chest were the seat of the lesions as an extension or metastasis from other parts. Dor cites the case of a man with primary lesions in the jaw and secondary in the lungs. Szenasy, on the contrary, records the case of a butcher's wife with carious teeth, but no appreciable actinomyces, who had suffered for nine years from a violent cough and severe pain in the chest, together with a growing and slightly fluctuating swelling on the right breast in the third intercostal space. Liquid drawn from this by aspiration showed actinomyces.

(6) *In the Brain.*—Bollinger records a case of primary actinomycosis of the brain in a man of twenty-six. There were severe headache, paralysis of the left abducens, congestion of the optic disk, and intervals of momentary unconsciousness. The lesion was found as a cysto-myxoma in the third ventricle, with affusion in all the ventricles. Two cases of secondary brain actinomycosis are reported by Keller and Gamgee and Delépine. Keller's patient, a woman of middle age, suffered from pleurisy, which in six months led to pointing of an intercostal abscess, with actinomyces in the pus. Two years later she had paresis of the left limb and side of the face, convulsions, and epilepsy, for which she was trephined, with temporary relief of the paralysis, followed by death a few days later. A mass of granulation tissue over the right frontal and parietal convolutions extended an inch into the brain, and beneath was an abscess as large as a nutmeg and containing actinomyces. In the case of Gamgee and Delépine there were left pleural effusion and a hepatic

abscess containing actinomyces, and in the frontal, parietal, and temporo-sphenoïdal lobes of the brain a mycelial growth without clubs.

Diagnosis.—While the symptoms will vary according to the organ invaded, and the correct diagnosis will always rest finally on the presence of the actinomyces in the lesions, yet there are certain indications which should lead to the suspicion of actinomycosis and consequent microscopic investigation. First, actinomycosis is habitually chronic: when it develops rapidly there is usually the early formation of abscess, in which the actinomyces are found. The specific product, apart from the parasitic growth, is granulation tissue, small round cells, and giant cells in a fibrous stroma of variable density, and it increases like a tumor, with comparatively little pain or tenderness, rather than like an inflammatory swelling. In advancing it invades the tissues indiscriminately, in this respect resembling a cancer. It differs from cancer, however, in its usual development under the integument, and in its invading the skin from within outward, whereas cancer tends to extend from the epithelial layers inward. It further differs from cancer, and equally from tubercle, syphilis, and glanders, in its indisposition to form secondary lesions in adjacent lymphatic glands, whereas in these other diseases such neoplasia in the glands are to be expected. As a further diagnostic symptom of tuberculosis and glanders, the injection of a small dose of tuberculin or mallein may be employed to produce febrile reaction in case one of these diseases is present. The patient's consent to the risk of such temporary aggravation of his disease should of course be obtained.

Prophylaxis.—In considering the wide range of causation it stands out clearly that certain soils are culture fields for the pathogenic actinomyces, and indications point to drainage and aëration of such soils as sanitary measures. If this is impossible, the soils should be withheld from pasturage or raising forage crops, especially such as are to be consumed by young teething stock and during winter. Foods raised on such soils for the use of man may be sterilized by heat. Actinomycotic cattle should be promptly destroyed or subjected to curative treatment, as the escaping seeds, whether dried up and conveyed on the air to food and water or lodged on vegetation or soil where they can grow and multiply, are calculated to increase the danger. The stables where diseased cattle have stood, above all the stalls and mangers, should be deluged with boiling water or treated with steam under pressure, and then soaked in a solution of 1 ounce of sulphate of copper in 8 ounces of water. The discharge from actinomycotic sores should be burned or disinfected. An important precaution is for human beings in actinomyces districts to maintain a healthy condition of the teeth and gums. Animals with actinomycosis should not be killed and marketed as dressed beef, but subjected to curative treatment. The carcass may, however, be safely marketed as canned meat.

Treatment.—Formerly actinomycosis was treated by surgical means only, embracing the excision of the tumors or later the scraping out of the granulation tissue with a strong sharp spoon, and the application of caustics to the cavity. Strong solutions of sulphate of copper proved very effective for purely local lesions, but manifestly such measures were useless for lesions of important internal organs. Since Bollinger's demonstration of the microphytic cause of the disease I have resorted

to iodized phenol, applied on tow or cotton to the cavities, after scraping out the diseased masses as completely as possible. This proved most efficient even in the worst local cases, the agent being at once a more efficient parasiticide than the copper, and a less destructive agent to sound tissues. In 1885, Professor Thomassen of the Veterinary College of Utrecht resorted to large doses of iodide of potassium internally, and by the use of this agent the disease has been virtually robbed of its terrors. It has now been very extensively applied in both Europe and America to cattle in all stages of the disease, and in the main with success. The most extensive test was by the Bureau of Animal Industry upon 185 cattle in all stages of the malady, and of which 131, or 71 per cent., rapidly and completely recovered. In all recent and moderate cases a cure is to be expected. It would, however, be unwise to omit local treatment wherever that can be applied. The swellings should be cut out or scraped out to their depth and the cavity filled with stupes saturated with iodized phenol. The iodide of potassium should not exceed 1 gramme (16 grains) for every 100 pounds of live weight of the animal. This is given daily for four or five days, when iodism will be shown by free secretion from the nose and eyes and some inappetence and costiveness of the bowels. A laxative diet and doses of laxative medicine will prepare the animal in two days for a second week's treatment, and a similar preparation will fit for a third, until the disease is cured. Recovery may be completed in from five to seven weeks. In man 20 to 30 grains daily has proved equally effective, even in apparently aggravated cases. The good result appears to depend on the destructive action of the iodine on the parasite, an exact parallel to its action on the achorion Schönleini of ringworm. Norgaard has cultivated actinomyces in gelatin containing 1 per cent. of iodide of potassium, but in the animal system the microphyte has already met with an inimical agent in the phagocytes, and it is only necessary to reinforce this by the internal iodine medication to put an end to its propagation in the tissues.

MISCELLANEOUS SUBJECTS.

PURPURA.

By GEORGE ROE LOCKWOOD, M. D.

Introduction.

Under the generic name "Purpura" are included a number of conditions having one symptom in common—namely, the circumscribed extravasation of blood under the skin. In the nomenclature of the subject authors differ considerably. By some the terms "purpura" and "hemorrhagic diathesis" are used to embrace all varieties of purpura, from the simplest form to that of the most fulminating type. By others are included under the same terms hæmophilia and scurvy.

It is evident that much confusion must necessarily result from such broad generalizations, and, although the true nature of purpura is as yet but little understood, it would seem better to attempt some form of classification. In the absence of definite knowledge of the pathology and bacteriology of the subject attempts have been made to classify the varieties of purpura according to the causation of each individual case. Such a classification is neither scientific nor practical from the clinical aspect. We know very little of the actual cause for the purpura in each case, although an assignable cause may seem apparent; and, on the other hand, under each etiological heading would be included cases presenting the greatest diversity of clinical types. A careful study of the cases shows such a variety in the symptoms presented and in their apparent etiological factors that it seems impossible even to regard them as different types of the same disease. In some cases the symptoms begin peracutely without assignable cause, associated with the symptoms of acute sepsis and capable of causing death within a few days or even hours. In other cases the symptoms begin gradually and run a subacute course, the constitutional symptoms being mildly septic. In other instances the disorder appears as a complication of some existing disease to which a definite cause or train of antecedent circumstances can be ascribed. In some instances we have purpura alone; in others purpura associated with hemorrhages from the free mucous membranes; while in other cases hemorrhages into viscera appear as evidences of the most formidable type of the disease.

It seems better, therefore, in the present state of our knowledge of the subject, to adopt a classification that is purely clinical in its scope, including under each class those cases that are similar in the symptoms

they present, although they may differ materially in pathology and etiology. Future advances in our knowledge, it is hoped, will furnish us with the means of classification on a more scientific basis.

The following is the provisional grouping adopted:

I. Symptomatic Purpura;
II. Purpura Rheumatica;
III. Purpura Hæmorrhagica.

I. Symptomatic Purpura.

Symptomatic purpura is that form which complicates some existing disease or to which a definite cause can be ascribed. The most usual form is that in which purpuric spots alone appear, usually first noticed on the extremities, although they may be more generally distributed. Their size varies from that of a pinhead to that of the palm of the hand. In severe cases we may have areas of ecchymoses sufficiently extensive to cause gangrene of the skin. The purpura may be induced by slight injuries or may follow the pressure lines of the clothing. More rarely hemorrhagic vesicles and bullæ may appear associated with the petechiæ.

Pain and swelling of the joints, especially those of the hands, feet, and knees, are frequently noticed, and are identical with the joint symptoms of purpura rheumatica.

Constitutional symptoms are not usually marked, moderate languor, anorexia, slight aching of the back and limbs, with slight elevation of temperature, being the symptoms ordinarily observed. When the constitutional symptoms are more marked than this they arise more from the original disease than from the complicating purpura.

Many of the conditions which are known to produce symptomatic purpura may also lead to the development of a purpura hæmorrhagica. These different types of severity can proceed from the same cause, acting more intensely in some patients than in others—either from a maximum of cause on the one hand, or from a minimum of personal resistance on the other. These cases of "symptomatic purpura hæmorrhagica" are more conveniently to be described in the class of symptomatic purpura, while under the heading of purpura hæmorrhagica proper are included only those cases which begin without known cause, in which the purpura and hemorrhages are associated with more or less marked septic symptoms, and which run a course resembling that of an infectious disease. To these cases the limiting term "essential" has been applied.

1. Purpura due to the Administration of Certain Drugs.

Potassium iodide, chloral hydrate, quinine, copaiba, salicylic acid —more rarely ergot, mercury, and belladonna—are the important drugs in common use which may give rise to subcutaneous hemorrhages. In regard to the extent of the purpura produced by these drugs patients differ greatly in susceptibility. In some no reaction at all is elicited even by the most heroic doses, while in others a simple purpura may result. In rare cases of great personal susceptibility, even without the

dosage being excessive, there may appear purpura, free and internal hemorrhages, high fever, collapse, and even death—a veritable picture of the acutest form of purpura hæmorrhagica. Stephen MacKenzie thus reports a fatal case in a child after a dose of two and a half grains of potassium iodide.

One peculiarity of drug purpuras should be noted—that the lesions show a greater tendency to become gangrenous than is the case with purpura induced by other causes.

2. Purpura due to Infectious Diseases.

This important class of purpuras may be caused by any severe infectious disease, and may appear in all grades of severity from a simple purpura to the most intense form of purpura hæmorrhagica. The commonest examples are to be found in the course of the exanthemata, so that the well-known names of "black measles," "hemorrhagic smallpox," etc. have been assigned to these cases. In typhus fever the hemorrhagic tendency is perhaps the best marked, as in nearly all of the cases the eruption is hemorrhagic to some degree. In acute yellow atrophy of the liver and in yellow fever hemorrhages from free mucous surfaces commonly occur, together with the purpuric spots. The bites of venomous snakes are to be classed with the above-mentioned diseases because of the frequency with which hemorrhages appear. It is doubtful whether the hemorrhages of scorbutus should be included under this heading or considered under the class of anæmic and cachectic diseases, and until the exact nature of scurvy is better understood this question will remain unsettled. Pneumonia, erysipelas, typhoid fever, and tonsillitis are additional examples of this group.

It may happen that the hemorrhagic diathesis exists before the other manifestations of the infectious disease. Davies reports a case of purpura in a child following scarlet fever. The maternal grandfather died of hemorrhagic smallpox; all the family on the maternal side bled profusely after slight injuries; and the patient herself suffered from previous attacks of subacute purpura hæmorrhagica.

The precise manner in which hemorrhages occur during infectious diseases must at present remain unsettled. Many authors attribute such a complication to an added infection of purpura hæmorrhagica (supposing that this disorder is an infection *per se*) complicating the primary disease. Henoch, for example, reports the case of a child with lobar pneumonia in whom a supposed infection of purpura hæmorrhagica occurred two days after crisis, causing death in collapse within twenty-four hours.

If a drug like potassium iodide will so disorganize the blood or render the bloodvessels so pervious as to allow of hemorrhages, why may not the poison of an infectious disease produce the same result without necessitating an added infection by a new disease? It is no argument against this view that purpura hæmorrhagica may appear after the crisis, because we know that a temperature crisis does not necessarily mark the termination of the disease, but only, as Fränkel has recently demonstrated in pneumonia, the end of the fever-producing quality of the infecting germ.

The better explanation of these cases is given by Roque—that as a phase of the irritative action of the infecting germ or toxin on the vasomotor nerves the small arteries become paralyzed, leading to stasis and hemorrhagic extravasation, the primary disease remaining the same whether purpura develops or not. It is impossible at the present time to determine whether the hemorrhages occur by reason of arterial stasis and an increased permeability of the wall of the bloodvessel, or whether the fault lies in some altered condition of the blood itself, by reason of which it is enabled to escape through the walls of normal bloodvessels.

In some of the cases of secondary purpura considered under this heading the local changes by which bleeding is allowed are more evident. Paul Claisse describes in this connection an interesting case of lobar pneumonia complicated by an old endocarditis, acute nephritis, and purpura. In the endocardiac vegetations, kidneys, spleen, lungs, and cutaneous petechiæ were found the pneumococci. It is a well-known fact that multiple minute emboli will be followed by small areas of extravasation by reason of the degeneration of the arterial wall at the point of occlusion. Examples of purpura induced by emboli are to be found described under a later heading.

In this connection, however, Paul Claisse's case is interesting when it is compared with the capillary embolisms described by Letzerich in his experiments with the bacillus of purpura hæmorrhagica.

3. Purpura due to Anæmia and Cachexia.

In this type the purpuric spots are usually confined to the lower extremities, wrists, and hands, more extensive hemorrhages being but rarely encountered. This form may accompany any exhausting or cachectic condition, however induced, and often appears in the aged without a known exciting cause.

It is not positively known whether the extravasations are due to altered blood conditions or to changes in the arterial wall, nor does it throw any light on the subject to call attention to the fact that in the so-called purpura of cancerous cachexia the discoloration may be due to the escape of hæmoglobin into the tissues, instead of being due to an actual hemorrhage. In leucæmia, pseudo-leucæmia, and in pernicious anæmia we meet not only with the simplest forms of purpura, but with free hemorrhages from mucous surfaces as well, and in these diseases, especially in leucæmia, the hemorrhagic tendency is so well marked that traumatisms and surgical operations, however slight, may be followed by uncontrollable, and even fatal, hemorrhage. This hemorrhagic tendency appears most strikingly when attention is called to the great mortality following splenectomy in this disease, compared with the low mortality following the removal of wandering or cystic spleens in non-leucæmic patients.

Hemorrhages appearing during the course of scurvy are shown by purpura, bleeding from mucous membranes and into internal parts, especially characteristic being the large subperiosteal hæmatomata. We cannot at present affirm that extravasations are due to the anæmia and cachexia consequent upon the disease, and are not the result of toxæmia following infection from some micro-organism at present unknown to us.

4. Purpura due to Continued Jaundice.

The cause for the purpura in these cases seems to be due to blood disorganization consequent upon the cholæmia. The hemorrhagic tendency is frequently so well marked as to render inadvisable those surgical operations that are not absolutely indicated.

5. Purpura Neonatorum.

Owing to the extreme delicacy of the arterial wall in infants, to the radical changes in the circulation that occur at birth, and possibly to alterations taking place in the blood itself, hemorrhages among the newly born are not infrequent, and comprise an interesting and important group of cases. Purpura occurs in about 1 per cent. of all newly-born children, although in the more recent statistics, owing, it is said, to improved methods of asepsis, the proportion of purpuric cases is becoming markedly diminished.

It is a curious fact that there is no apparent connection between hæmophilia and purpura neonatorum, and that surgical operations may be performed upon these infants within a few days even after the cessation of purpuric symptoms without risk of serious hemorrhage. While purpura appears most commonly upon parts of the body exposed to pressure, as, for instance, along the friction lines of the clothing, other hemorrhagic spots appear spontaneously, so that the purpura has evidently nothing to do with the traumatic ecchymoses and hemorrhages consequent upon labor.

The characteristic features of purpura neonatorum are—(1) The spontaneous appearance of hemorrhagic effusions; (2) their multiplicity; and (3) the fact that the disease runs a self-limited course, terminating either in death or in permanent and complete recovery.

The onset usually occurs during the first three days of extra-uterine life. The most common situations for the hemorrhages are under the skin, from the navel, and from the mucous membrane of the gastro-intestinal tract; in other and rarer cases the hemorrhages are more general, occurring from any of the mucous membranes or into the internal organs.

Purpura neonatorum may be divided into three sets of cases:

(*a*) **Purpura of the Newly Born, with Arterial Changes of Hereditary Syphilis.**—This group comprises 2 to 6 per cent. of the total number of cases of purpura neonatorum, but in this group are included a large proportion of syphilitic infants. Bumstead and Taylor have described these cases in detail under the name of syphilis hæmorrhagica neonatorum. The almost constant occurrence of endarteritis has been proved by the recent studies of Mracek.

(*b*) **Purpura Neonatorum without Arterial Change.**—Concerning the pathogeny of these cases there has been considerable doubt. It was formerly considered that the change in functional activities and the alteration of circulation that occur at birth allow of a brief interruption of the nutrition of the smaller arteries, sufficient for the transudation of blood through them. Were this view correct, it would be difficult to account for the high mortality-rate (60–75 per cent.) as due to a merely functional derangement in an otherwise healthy infant, and, moreover, there would be unexplained the diminishing frequency of

these cases coincident with the improved antiseptic technique of our midwifery cases.

The generally accepted belief at the present day is that these cases are probably of septic origin, the infection occurring through the umbilicus. That the navel may not appear inflamed does not militate against this view, as in many cases even of septico-pyæmia in infants the umbilicus is not itself involved—to any apparent extent, at least—although it has been the channel for infection.

Gärtner has recently found a bacillus in these cases which closely resembles the colon bacillus, but differs from it in important particulars.

(*c*) **Purpura of Buhl's Disease.**—This disease, of an unknown essential nature, is characterized by fatty degeneration of viscera, especially of the heart, liver, and kidneys. Besides the constitutional symptoms, prostration and malnutrition, purpuric vomiting of blood and bloody stools are commonly present. In many cases there appear icterus and œdema. The umbilicus preserves a healthy appearance, and there is no elevation of temperature.

The DURATION is about two weeks; the disease is uniformly fatal.

6. Embolic Purpura.

Purpura due to embolism is most often seen with malignant endocarditis and multiple sarcomata. In the former case the purpura and hemorrhages seem to be clearly due to the degeneration and rupture of the smaller bloodvessels which have been occluded by vegetative fragments. In the case of multiple sarcomata, however, it is hard to say whether these symptoms result from the blood changes of cachexia or from embolism by sarcoma fragments.

7. Neurotic Purpura.

The influence of the nervous system in the causation of purpura is mysterious and startling. Many well-marked examples of this form have been recorded in literature, especially of the hysterical and religious type, where stigmata occur upon the hands and feet. Purpura may appear after fright, emotional crisis, hysterical attacks, during hypnotism, or as the result of severe neuralgia or of certain inflammations of the spinal cord. It is not known whether the purpura is due to vasomotor relaxation or to an actual enfeeblement of the arterial wall. Usually in neurotic purpura the cutaneous phenomena are alone present, free hemorrhages from mucous membranes occurring only in a small number of cases. As an example of the intenser form is cited the case of a young woman, whose child being sick with purpura, suffered herself from a purpuric eruption and hemorrhages from the bowel and uterus. The neurotic element was shown by paræsthesia, a trance-like condition, and by the fact that the attack was subsequently repeated on every slight emotional provocation.

II. Purpura Rheumaticia; Peliosis Rheumatca; Schonlein's Disease.

As ordinarily described, purpura rheumatica is characterized by the combination of purpura with pain and swelling of the joints, or arthri-

tis. The propriety of considering it as a separate variety of the disease is questionable.

Schönlein originally gave the name "peliosis rheumatica" to an eruption of bright red spots, changing later to brown and yellow, which were situated on the legs of rheumatic patients below the knees. As these spots disappeared at first on pressure, it is evident that the affection which he described was some form of erythema, certainly not purpura. Some authors still employ Schönlein's term as synonymous with erythema nodosum, and this must be remembered when consulting the literature of the subject.

The term "purpura rheumatica" itself is loosely applied to any one of the following conditions:

1. *Cases of erythema* complicating rheumatism, either erythema nodosum, which is almost invariably the seat of ecchymoses, or to erythema papulatum or marginatum, into which hemorrhages may also occur. In these cases urticaria seems to be very frequent, so that the combination of purpura, resulting from the fading of a primary erythema into which hemorrhage has occurred, together with the fresher evidences of erythema exudativum and wheals, is very distinctive. These manifestations are usually encountered in male rheumatic subjects between the ages of twenty and thirty. The affection is commonly preceded by sore throat and accompanied by fever of moderate severity and by painful swelling of the joints. The joint affection does not seem to be rheumatic in the true sense of the word, and is usually rebellious to salicylic acid; neither does the eruption appear sufficiently purpuric in character to be included among the types of purely purpuric diseases.

2. *Purpura simplex* (symptomatic purpura) may occur in old debilitated rheumatic patients as an evidence of anæmia and debility, or in younger subjects as the result of too large doses of salicylic acid.

3. *Painful swellings of the joints*, synovitis, or actual arthritis may be developed in any case of purpura, scurvy, or hæmophilia without any relation whatever to rheumatism. The joint symptoms seem to be due to hemorrhages taking place in and about the joints, and have been elsewhere described. Of these three types, the first alone appears to be entitled to the distinction of the name, although even here the propriety of the term is doubtful.

III. Purpura Hæmorrhagica.

Under the term "purpura hæmorrhagica" is included a clinical group of cases characterized by the association of purpura with hemorrhages from any of the mucous membranes, less frequently into serous membranes and joints or into the substance of the viscera. First described by Werlhof in 1775, it is often known as "Werlhof's disease." It is also termed "morbus maculosus," especially by German writers.

The study of purpura hæmorrhagica is rendered more clear by dividing the cases of this disease into two groups: (1) *Essential* cases, in which the disease begins without known cause, the hemorrhages and the

purpura being associated with more or less marked septic symptoms and running a course resembling that of an infectious disease; and (2) *Symptomatic* cases, which arise from a well-known cause or as a complication of a severe blood or infectious disease.

The essential cases appear to the author to constitute the only true group to which the term purpura hæmorrhagica should be rightly applied, and will therefore be described more fully than the symptomatic cases, of which mention has already been made.

1. Essential Purpura Hæmorrhagica.

A subacute and an acute form are to be described:

Subacute Purpura Hæmorrhagica.—This, the most common variety of the disease, usually attacks those who are poorly fed and who live in squalor and misery, although these determining factors are not so marked as in scurvy. It is not, however, uncommon for those who are healthy and well fed to be the victims of this disorder. While no age is exempt, the disease appears to be more common among children and young adults. Females are apparently more susceptible than males. There appears to be no relation between morbus maculosus and hæmophilia, although in two cases of the former disease in young girls under the author's observation the father of each had suffered in youth from serious attacks of epistaxis.

Whether there is an element of infection in the disease, or whether different members of the same family are liable, independent of each other, to the same infection, is unknown, but it is certain that a number of the members of a family may be attacked at about the same time. Grüning, for example, reports three such cases in children of one family, three, four, and sixteen years of age respectively, while Forster reports a similar number of cases simultaneously affected.

The subacute cases present themselves in two clinical forms—(1) ordinary cases; (2) cases of Henoch's disease.

1. *Ordinary Subacute Cases.*—Symptoms.—Although *prodromal symptoms* may not be present, it is usual for the patient to complain of anorexia, malaise, chilly sensations, and irregular elevations of temperature, especially during the afternoon, for several days or weeks preceding the actual onset. When the disease is fairly developed we have both *hemorrhagic* and *constitutional* symptoms.

Hemorrhagic Symptoms.—Purpuric spots usually appear first on the extremities, where they may remain limited or may become more generally distributed. In size they vary up to that of the palm of the hand, although they are not usually larger than pinheads. In severe cases there may be large areas of ecchymoses. Subsequent gangrene is not as common in the essential cases as in symptomatic drug purpuras. During the course of the disease successive crops appear, and these may often be produced by rubbing or scratching the skin. The eruption also appears commonly along the friction lines of the clothing and on the pressure points of the body upon the bed. In rarer instances there are associated with the purpura hemorrhagic vesicles and bullæ.

Hemorrhages from free mucous membranes occur in purpura hæmor-

rhagica, and give to it its distinctive name and characteristics. The most common sources of bleeding are from the nose, pelvis of the kidney, intestines, and uterus, in the order named—less frequently from the mouth, gums, stomach, and bronchi. The hemorrhages appear more or less spontaneously, and not from traumatism alone, as is the case with hæmophilia. They may be moderate in extent or they may be so profuse and obstinate as to endanger the life of the patient.

Pain and swelling of the joints may occur as in purpura rheumatica, the joints of the hands, feet, and knees being most frequently affected. These symptoms are due to hemorrhages occurring in and around the joints. The fibro-serous tissues of the joint may be simply swollen or the joint-cavity may be filled with serous or fibrino-serous effusion. As sequelæ of the severer forms of joint involvement ankylosis or arthritis may result.

Internal hemorrhages may occur at any time and into the substance of any of the viscera, but are infrequent in the subacute form, although common in the acuter varieties. The brain and its membranes, the suprarenal capsules, and the lungs are the most frequent seats of internal hemorrhage. The gums are usually normal, but they may be swollen and bleed easily, as in scurvy, although this is strenuously denied by some authors. They may be the source of hemorrhage, although apparently normal in other respects. An important distinction, however, from scurvy is in the fact that the teeth are not loosened, as in the latter disease.

It is generally asserted that intestinal ulcers due to submucous hemorrhage do not occur. It would seem, however, that ulceration, caused in this way, might occur as it does in Henoch's disease—a condition quite similar to the form of purpura hæmorrhagica now under discussion. Free hemorrhage from the skin does not occur. Nephritis has not been observed.

Constitutional symptoms are due both to anæmia and to moderate sepsis. Chilly feelings usually occur at the onset and throughout the disease, although a definite initial rigor is but rarely observed. The temperature runs an irregular course, usually fluctuating between 100–103° F., more rarely reaching 104° in severe cases and in children. As the severity of the attack subsides the temperature gradually attains the normal. A fall in temperature with a subsequent rapid rise is noted in case of sudden severe hemorrhage, especially if such occur internally. The pulse is rapid and of low tension, the circulatory disturbances depending largely upon the extent of the anæmia induced by the hemorrhages; attacks of syncope are frequently observed.

Anæmic symptoms are noticed early in the disease, and are always present, even though the actual amount of the bleeding be slight. After large hemorrhages, however, anæmic symptoms are more pronounced. The anæmic condition persists during convalescence, which is slow and tedious, and it may require weeks or months before the blood returns to the normal standard of health.

At the time of the onset of the disease the examination of the blood shows a rapid diminution in the number of the red corpuscles and a corresponding reduction in the percentage of hæmoglobin. As is the case in acute anæmia after hemorrhage, the white cells are at first

increased in number, but later tend to diminish even during convalescence, when the number of red cells and the percentage of hæmoglobin are steadily increasing. These facts are well shown in the record of blood examination made by Osler in a case of purpura hæmorrhagica reported by him:

	Number of red cells.	Number of white cells.	Per cent. of hæmoglobin.
1st day	5,350,000 (107 per cent.)	8,000	95
2d day	3,000,000 (60 ")	12,500	50
8th day	2,500,000 (50 ")	12,500	37
14th day	3,000,000 (60 ")	7,000	47
50th day	4,000,000 (80 ")	2,500	62
70th day	4,250,000 (82½ ")	"	72

Prostration is a well-marked symptom, and is more profound than can be accounted for by the anæmia and the constitutional symptoms. It occurs during the earlier stages of the disease, and remains for weeks after other symptoms of the attack have disappeared. In the severer cases the patient may even pass into the "typhoid condition," with rapid and feeble pulse, dry brown tongue, stupor alternating with mild delirium, coma, and even death.

The liver and spleen are usually enlarged during the acme of the attack, furnishing us with another link of the chain which binds purpura hæmorrhagica to the group of acute infections. The enlargement of these viscera may continue weeks or months after the attack. Much interest is attached to the hepatic enlargement in these cases in connection with Letzerich's bacterial studies on the subject. The congestion and enlargement of the liver often give rise to a mild degree of jaundice, which, combined with the anæmic appearance of the patient, gives a light fawn color to the skin.

The DURATION of the attack varies from a few days to several weeks, but the disease may be protracted months, or even years, by a succession of similar attacks, or "relapses" as they are sometimes called. There are usually three to five such relapses, recurring at regular or irregular intervals. In a unique case under personal observation the attacks have covered a period of fifteen years, without any indication of their abatement. The next longest case of duration is reported by Hryntschek—a boy who suffered for seven years from repeated attacks.

NATURE AND PATHOLOGY.—For the blood to escape from the vessels and cause hemorrhage we must naturally conclude that the vessel wall must first rupture. As this does not normally occur, except from traumatism, we must also conclude that its wall is weakened either from inflammation or from degeneration due to disease, to poor blood supply, to toxic blood, or to thrombi. Much light has been thrown on the subject by Silberman, who gave to fifteen dogs small, steady doses of pyrogallic acid until there appeared areas of stasis in the small arteries, capillaries, and veins. After pressing out the stasis blood he injected fibrin-ferment into the arteries. The dogs had abdominal tenderness, purpura, bloody vomiting, and bloody stools. Autopsy showed in the hemorrhagic areas thrombi in the small arteries, whose walls had undergone hyaline degeneration, with areas of necrosis, thus allowing the free escape of blood.

Many attempts have been made to discover a specific bacterium, but before the time of Letzerich the examinations were so incomplete as to be entirely without value. Letzerich, however, in 1889 made scientific bacterial examinations, and discovered a bacillus which he believes to be the specific germ of the disease. Although his experiments have not been fully corroborated by others, their result still remains of the greatest value. His patient was a girl suffering from the subacute form. Bacterial examination, carefully performed, showed in the purpuric spots the presence of long bacilli capable of growth in gelatin, the pure cultures of which, injected into the abdomen of rabbits, reproduced the original clinical symptoms in all of the twelve cases, and in these a bacillus was found identical with that in the pure culture injected. An examination of the purpuric spots in the rabbits showed dilatation of the capillaries, emigration of white cells, and rupture of the capillary wall, permitting the escape of red cells. The capillaries were filled by the bacilli with abundant spore growth.[1] Upon squeezing the section Letzerich found that little plugs resembling hyaline casts emerged from the capillaries, and these he considered the result of the action of the bacillus or its products upon the fibrino-plastic elements of the blood. The liver in the rabbits was regularly enlarged, and the portal capillaries were almost occluded by an extraordinary growth of the bacilli. Letzerich considers the liver to be the breeding-place of the bacilli, the liver being to this disease what the spleen is to malarial fever. If he be correct in his conclusions, they explain both the scattering of the lesions—a bacterial embolism of the capillaries causing hyaline thrombi within them and rupture of the vessel wall—and also the tendency of the disease to relapse. While conducting his experiments Letzerich was himself attacked by the disease, with three relapses, and attributes his infection to handling his cigar while at work. This case of infection seems to prove the advisability of disinfection after an attack.

In a more recent article on the subject Letzerich is indisposed to add new light upon the subject. According to this authority, the bacillus purpuræ closely resembles the anthrax bacillus, with a similar appearance of the colonies when grown in nutrient media, but differing in the size and appearance of the spores. The bacillus purpuræ, moreover, does not develop as active a toxin as the bacillus anthracis, and is not a fever-producer, as are the vast majority of infective microorganisms.

Kolb has in five cases found long, motionless bacilli with rounded, ends, closely resembling Letzerich's bacillus, if not identical with it, the cultures of which injected in animals produced purpura: in these purpuric spots large numbers of these bacilli were found. It is interesting in this connection to compare Letzerich's and Kolb's experiments with the results found by Paul Claisse in the case of symptomatic purpura following pneumonia already alluded to (p. 793).

Prognosis of the subacute form is generally good, as almost all patients recover from the primary and secondary attacks, but recovery is slow, the anæmia and prostration persisting for weeks or months,

[1] The bacilli and spores had been previously described by Petrone in his examination of a case of Werlhof's disease, but were considered by him due to a mixed infection.

especially if there be a number of successive attacks. The occurrence of the secondary attacks cannot be foretold, so that a prognosis as to duration must always be guarded.

In rarer instances the disease terminates fatally, the cause of death being either profound anæmia, fatty degeneration of the heart with or without dilatation, visceral hemorrhages, or exhaustion.

2. *Henoch's Disease.*—This somewhat rare form of purpura hæmorrhagica was first described by Henoch, and is known as Henoch's disease or Henoch's purpura hæmorrhagica. While it has been observed between the third and forty-sixth years, it occurs in children with the greatest frequency, especially in those between the ages of nine and twelve. It occurs five times more frequently in males than in females.

Symptoms.—There is usually a short prodromal period, characterized by malaise, slight fever, and in some cases by pain in the joints. The onset is marked by the appearance of purpura, in severe cases accompanied by large ecchymoses. Immediately after the purpura appear the severe abdominal symptoms so characteristic of the disease. There are marked pain and tenderness over the abdomen, the pain being of a colicky character, with exacerbations of great severity. The abdominal wall is rigid and retracted. There is severe rectal tenesmus with bloody stools. Vomiting is usually distressing, the vomited matters being either like those of gastritis or containing blood. These abdominal symptoms seem to be due to submucous hemorrhages or to hemorrhagic infarctions occasioned by thrombi in the small bloodvessels of the gastro-intestinal wall, and whose walls, becoming degenerated, rupture and allow the free escape of blood. Intestinal ulceration may result in rare instances, and rupture into the peritoneal cavity may occur even after apparent recovery.

The symptoms continue with great severity for from one to two days, and then subside gradually. They may continue longer than this, but in the more protracted cases there are usually intervals of temporary improvement. Joint symptoms may appear as in the ordinary variety of purpura hæmorrhagica. Hæmaturia occurs in about one-fifth of the cases. The spleen is generally enlarged, and the temperature is somewhat elevated during the attack.

There are usually recurring attacks or relapses at short intervals. There are generally four to five such recurrences, but there may be as many as twenty.

The nature of the disease is not accurately known. The recorded cases are not numerous, and no authenticated bacterial investigations have been made.

Duration varies according to the length of the individual attacks, the number of the recurrences, and the intervals between them. The whole duration usually extends from six to twelve weeks, but it may be limited to one week or be protracted to nine months.

Prognosis is fairly good, being better in children (mortality 5 per cent.) than in adults (mortality 25 per cent.). The possibility of intestinal perforation, though rare, must be always kept in mind.

Acute Purpura Hæmorrhagica.—The acute variety, which is far more rare than is the subacute, presents in the main the same essential symptoms, but in a more aggravated and fulminating form. Aside from

the greater rapidity of its course, three characteristics mark the acute form: (1) the severity of the toxæmia; (2) the greater tendency to visceral hemorrhage; and (3) the greater disposition to attack pregnant women. The cases may be clinically grouped according to these characteristics.

(1) **Cases with Marked Toxæmia.**—There is no known cause for the disease. Men are attacked more frequently than women, and, while the average age of male patients is twenty-eight, that of the female patients is only twelve. Any age, however, is liable, cases having been reported between the ages of one and seventy years.

The attack begins suddenly with a chill or chilly feelings, followed by a rapid rise of temperature to 103–104° F. Purpura and hemorrhages from free mucous membranes, especially from the nose, gastro-intestinal tract, and pelvis of the kidney, rapidly follow. These hemorrhages are severe and cannot readily be controlled. Toxæmia of a profound character becomes marked, especially at the onset, severe prostration, mental apathy, stupor, or semi-coma alternating with periods of restlessness, anxiety, and mild delirium, and finally, in fatal cases, complete coma. The temperature remains high, 103–104° F., and in severe cases may attain the height of 105–107° F., especially before death. The pulse becomes rapid, feeble, and irregular. Death usually results from anæmia or from toxæmia.

A good example of the COURSE of the acute form is given in the following history of a case personally observed:

L. M———, female, nineteen years, had always lived in most affluent circumstances, and, except for a moderate anæmia for two years previous to the attack, had never been ill. Father would bleed severely from slight injuries, and suffered from repeated epistaxes when a boy, but no further history of hæmophilia is to be obtained.

March 7, 1 A. M.—Slight chill without rise of temperature. Very anxious and nervous. Has been perfectly well for the preceding weeks. 12.45 P. M.—Marked rigor. Temperature 103.5° F. Developed epistaxis, becoming more and more profuse in spite of every effort to check it.

March 8, 1 P. M.—First seen by author. T. 98.4°; P. 130, irregular and weak. Pallor of skin and mucous membranes; prostration profound; complete mental apathy, although her mind is clear when she is aroused. Purpura rapidly appearing. Gums normal. No evidence on examination of any appreciable disease. Spleen enlarged; epistaxis continuing, the blood being dark and not coagulating. Profuse uterine hemorrhage. Hemorrhages were checked finally by plugging the anterior and posterior nares with cotton dipped in collodion and by firmly applied tampons.

8 P. M.—T. 102.8°, P. 130–180, more weak and irregular; semi-coma alternating with periods of restlessness and mild delirium. Hemorrhage from nose and uterus continues in spite of former treatment. 10 P. M.—Warm sterilized salt solution was injected by rectum and hypodermically, with slight but temporary improvement. Whiskey and digitalis in large doses failed to make any impression upon the weakening action of the heart.

March 9, 9 A. M.—T. 104.8°, R. 32, P. 148. Large offensive, tarry

stool of altered blood. Injection of saline solution continued. No improvement.

6 P. M.—Complete coma; T. 106.2°; pulse flickering.

March 10, 2 A. M.—She died two and a half days after the onset of the disease. No autopsy was permitted, and bacterial examinations could not, at the time, be made.

PROGNOSIS of this form is bad, 75 per cent. of the cases terminating fatally.

The DURATION varies between one and four days, but life may be protracted somewhat longer than this.

(2) **Cases with Visceral Hemorrhages.**—Any organ may be the seat of hemorrhage, but the brain and membranes and the suprarenal capsules are most frequently affected. In the cerebral cases the disease begins with the symptoms of acute purpura hæmorrhagica, followed by those of meningeal or cerebral hemorrhage. Of diagnostic value are—(1) that the hemorrhages are usually multiple, and (2) that there is no special seat of selection. The duration of these cases is short, death usually resulting shortly after the occurrence of cerebral symptoms. As illustrative cases may be cited the following:

1. Girl, two years of age. For two days diarrhœa and vomiting; then purpura, fever, and collapse. Death in a few hours from multiple hemorrhages into the medulla (Züelchauer).

2. Young man, with acute purpura. Death on the fourth day from hemorrhages into the left Sylvian fossa, pons, and ventricles (Kurkowski).

When hemorrhage occurs into the adrenals the course of the disease is exceedingly short, and the patient may die a few hours even after the first appearance of symptoms, as in the following cases:

1. Soldier, aged twenty-two. Purpura; hemorrhages from lungs, mouth, and kidneys. Died in seven hours from adrenal hemorrhage (Bourrieff).

2. Male, two years and nine months. Purpura, fever, and collapse. Death in fifteen hours from hemorrhage into the adrenals (Wolff).

(3) **Cases complicating pregnancy** are usually followed by miscarriage and post-partum hemorrhage. The disease commonly appears during the sixth or seventh month, but it may follow labor at term.

The COURSE of this type of purpura is rapid and recovery from it is rare.

Illustrative cases:

1. Patient aged twenty-one, six months pregnant. Purpura for four days; then rapid onset of increasing purpura, with hemorrhages from the nose, gums, kidneys, and stomach. Miscarriage on the sixth day, with post-partum hemorrhage. Death on the eighth day of the disease, four days after the development of acute symptoms (Puech).

2. Patient, aged thirty, seven months pregnant, with the history of five normal labors. Purpura, followed in a few hours by miscarriage and post-partum hemorrhage. Death on the second day (Phillips).

TREATMENT OF PURPURIC DISEASES.—1. *Symptomatic Purpura.*—The chief indication for treatment is to combat the primary disease or, in cases of drug purpura, to discontinue the offending cause. Aside from

this little can be done for the hemorrhagic tendency directly. In the majority of cases free stimulation is necessary. For the hemorrhages from mucous membranes the special lines of treatment mentioned later are to be adopted.

2. *Purpura Rheumatica.*—The treatment of the cases described under this heading depends upon which particular type falls under observation.

In the *first set of cases*, where erythema occurs with purpura and joint pains, salicylic acid and an antirheumatic regimen may be prescribed with the anticipation of considerable benefit. The drug, however, should be given in small doses, and the constitutional effects carefully avoided, as more generous dosage would have the effect of increasing the hemorrhagic tendency and of even giving rise to a symptomatic purpura.

In the *second set of cases* of symptomatic purpura occurring in rheumatic patients the treatment must necessarily vary according to whether we are confronted with the purpura of cachexia and anæmia or with purpura due to the treatment of the rheumatic state by salicylic acid or by potassium iodide. When the underlying cause in either case is appreciated, the lines for treatment are clearly drawn.

In the *third set of cases* the treatment is that of the purpuric disease in general. The local treatment for the affected joints has been elsewhere described. In these cases considerable benefit may result from salicylate acid or its congeners, but the drug must be most sparingly used, for the reasons previously mentioned.

3. *Purpura Hæmorrhagica.*—(*a*) *Subacute Cases.*—Treatment is unsatisfactory both in mitigating the attack and in preventing recurrences, as there is no known specific for the disease. During an attack we endeavor to check the hemorrhages and to relieve constitutional symptoms.

To check the hemorrhages a number of hæmostatics may be employed, such as aromatic sulphuric acid, ergot, turpentine, digitalis, acetate of lead, gallic and tannic acids; but no one drug is certain. We employ in turn a number until one is found efficient, but we may, on the other hand, exhaust the entire list without result. Saundby recommends chloride of lime in 4½-grain doses twice or thrice daily, and claims good results when all else has failed. Sansom has given sodium sulphocarbolate in half-drachm doses every four hours for long periods, with marked improvement. Two cases so treated recovered promptly, although at the start recovery seemed impossible. Small doses of antipyrine (2–5 grains) every two or three hours have also been recommended. Sodium benzoate in 3–5-gramme doses, given in divided doses throughout the day, also seems serviceable and is well worthy of trial.

During a hemorrhage the patient must be kept absolutely quiet, even though morphine be required for the purpose. In all cases and at all times care should be taken to guard against traumatism, over-exertion, and excitement. During the acuteness of the attack the patient should be kept in bed and on a low diet; later he may be gradually allowed to go about and the diet is increased, vegetables and fruits being especially indicated. The bowels must be kept moderately open, but over-use of laxatives is contraindicated, as intestinal hemorrhage may thereby be induced. Alcohol and highly seasoned food are at no time permissible.

Epistaxis may be treated by astringents or by sprays of 5 per cent. solution of antipyrine. Obstinate cases, however, require efficient plugging. Uterine hemorrhage may be controlled by tamponage.

If symptoms of sudden profound anæmia arise, we apply warmth to the body, heat to the præcordium, and give cardiac stimulants, especially opium in small doses, digitalis, and strychnine. Inhalations of oxygen gas are serviceable. In severe cases salt solution (ʒj–Oj) may be given by rectum, or in case of intestinal hemorrhage sterilized saline solution may be injected hypodermically. Arterial or venous transfusion is not to be employed, on account of the danger of traumatic hemorrhage. Elevation of the foot of the bed and ligatures applied to the extremities may also be tried.

Constitutional symptoms are to be treated on general principles. The joint symptoms, if present, may be alleviated by anodyne solutions, such as lead and opium, by hot applications, or by ichthyol or iodine ointment. Firm compression is often grateful. Salicylic acid seems to be occasionally of service.

Should the pulse become weak, cardiac stimulants may be given, digitalis and strychnine being the best that can be employed. Alcohol is contraindicated. In protracted cases and during convalescence a tonic regimen is indicated. Of tonic drugs the best are quinine, arsenic, and strychnine in combination. Iron should not be prescribed until the hemorrhagic tendency has entirely disappeared, as experience has shown that its too early administration may induce fresh hemorrhages or may precipitate a recurrence.

In these cases arsenic in full doses may be employed with benefit, and should be continued until the blood is normal. Iron may be gradually added after a time, but it should be discontinued at any time that a relapse threatens.

In protracted cases and in those with a series of recurrences a change of climate is to be advised. The most suitable climate is one in which the air is dry and bracing, and must be inland, as it is found that the disease prevails most extensively along the sea-coast. The temperature of the place selected should be sufficiently warm to enable the patient to be out of doors without the necessity for forced exercise, for the maximum of fresh air is of the utmost importance.

As the disease is probably due to an infectious and specific microorganism, and as the consequent relapses are probably due to reinfection, it certainly seems better to disinfect the rooms and the clothing of the patient after the illness. The more we study the disease the more we incline toward such disinfection.

(*b*) *Acute Purpura Hæmorrhagica.*—As the course of the acute cases is that of an intense infection with extreme prostration of all the vital powers, stimulation becomes an important factor in treatment. It may be even necessary to employ alcohol for the purpose, although it is contraindicated as a routine treatment in the subacute cases. The hemorrhagic tendency should be combated by the lines of treatment described in the previous section: larger and more efficient dosage, however, is prescribed.

Sodium benzoate in 10-grain doses, sodium sulphocarbolate in ʒss-doses, or chloride of lime in 4½-grain doses may be given every three

hours, in addition to the more purely mechanical means for controlling hemorrhage. There seems to be marked benefit, for a time at least, in copious rectal injections of normal salt solution, and this procedure should not be omitted as a routine practice. When internal hemorrhages occur surgical interference is unjustifiable, for, aside from the danger of traumatic hemorrhage that is incurred, the hemorrhages, especially in the cerebral cases, are usually multiple.

BERI-BERI.

By JAMES STEWART, M.D.

Synonyms.—Barbiero; Kak-ké.

Beri-beri has been known for upward of two hundred and fifty years, having been described by Bontius in the year 1645 under the name of *Bèriberìa*.

Definition.—Beri-beri is an infectious disease, occurring endemically and epidemically in Japan, China, Ceylon, India, the Malayan Peninsula, Burmah, Siam, on the West Coast of Africa, Brazil, and among the fishermen of the Banks of Newfoundland.

Etiology.—It occurs chiefly among men. It is met with in women rarely, and then generally after childbirth. Living in overcrowded and badly ventilated rooms predisposes to it, as does also mental and physical depression. It is most common in people who live on a diet poor in albuminous elements. The immediate cause of the disease is, in all probability, a micro-organism. The endemic character of the disease and the fact that persons affected, when removed to higher altitudes, recover, gives strong support to the view that it is due to an organism. Organisms of various forms have been discovered which, when injected into animals, produce similar symptoms to beri-beri. It is considered that the organisms float in the air and give rise to infection through inhalation.

Pathological Anatomy.—The chief changes met with are in the peripheral nerves. In fatal cases these changes are marked and constant, and consist in a degenerative neuritis. All degrees of the degenerative process are to be met with in different nerves, from increase of the segmental nuclei and shrinkage of the medullary sheath up to complete disappearance of the axis cylinder and entire breaking up of the white substance.

Signs of beginning degeneration are frequently met in the vagus branches, especially the cardiac ones. This explains the fatty degeneration of this organ so commonly met with. Degenerative changes are also met with in the voluntary muscles, being secondary to the nerve changes. It is unusual to meet with changes in any of the cranial nerves except the vagus. Serous effusions into the serous cavities are very constant and often copious, especially into the pericardium.

Pathology.—Pickelhering and Winkler consider they have found a micro-organism in the blood of patients affected with beri-beri. They claim that they have been able to induce in rabbits and dogs a peripheral polyneuritis by the injection of a cultivation from the micro-organism found in the blood of human subjects. Von Ecks describes two kinds

of cocci and a polymorphous micro-organism, any one of which he considers capable of inducing the disease. Other observers have described still other forms. In the face of these different views as to the real morbific agent it would be premature as yet to consider the subject as settled. There is, however, sufficient evidence to conclude that the disease is due to a micro-organism, although its true morphological characters have not been worked out.

The chief symptoms appear to be induced by the product, and not by the micro-organism itself. In its chief symptoms beri-beri resembles closely chronic arsenical and alcohol poisoning.

Symptoms.—The most characteristic symptoms of beri-beri are those resulting from the degenerative neuritis of the peripheral nerves. They are (1) paralysis and muscular atrophy of the limbs, especially of the legs; (2) cardiac weakness from involvement of the cardiac branches of the vagus. The paralysis in the great majority of cases begins in the lower limbs, and in severe cases gradually extends upward, and may ultimately involve the upper limbs, and even the face and the tongue. Paralysis of the diaphragm from degeneration of the phrenic nerve is occasionally met with. The nerves of the larynx are sometimes involved in the degenerative process.

Sensory disturbance is a marked feature in all severe cases, tactile sensibility being usually much diminished or lost, while the sense of pain is commonly retained. The muscles, as in alcoholic and arsenical neuritis, are acutely painful on pressure. The muscles of the lower limbs present in well marked cases signs of rapid atrophy and the reaction of degeneration. The deep reflexes are abolished. In certain cases ataxia of movement is a prominent symptom.

Serous transudation into the cavities and subcutaneous tissues is a marked feature of certain cases ("wet type"). The œdema is generally first noticed in the lower limbs, and spreads so as to become general in the subcutaneous tissues, and often involves at the same time the peritoneal, pleural, and pericardial cavities.

According to Max Simon, death may be brought about in three different ways: (1) by failure of the heart from paralysis of its special nerves; (2) by suffocation from congestion and œdema of the lungs; (3) by effusion into the pericardium.

Beri-beri is essentially a non-febrile disease. Relapses are very frequent, and with each relapse the danger of fatal termination becomes greater.

The disease is met with in all degrees of severity, from cases presenting only very slight sensory or motor defect up to cases described as of an acute pernicious type.

Diagnosis.—The diagnosis of beri-beri can only be a matter of difficulty in isolated examples of the disease met with in parts where it is not endemic. From alcoholic or arsenical neuritis the differential diagnosis would in the earlier stages be very difficult, if not impossible. The presence of dropsy and other signs of cardiac debility would be in favor of beri-beri.

Prognosis.—According to Bentley, the percentage of deaths varies much in different epidemics and in different countries. In Singapore it varied from 16.2 in 1878 and 20.9 in 1879 to 8.02 in 1880. The

army returns for the whole of Japan for 1875 show a death rate of 17.65. In India the death rate varies from 14 to 26 per cent.

TREATMENT.—The patient should be removed at once to a non-infectious district. In mild cases recovery quickly follows such a change.

Thorough disinfection should be carried out if the disease breaks out in places where bodies of men are congregated, as in jails, camps, etc. It is important that the drainage of such places should be looked into, and if found insufficient deep drains should be made, so as to carry away the moisture from the surface. It is important to avoid overcrowding, for it is a well established fact that the disease spreads most rapidly and is of a severer nature when large bodies of men are housed together.

The symptomatic treatment of beri-beri comprises, chiefly, (1) the relief of pain; (2) the treatment of the paralysis; (3) the strengthening of the heart. For the latter condition Bentley in his extensive experience with this disease in the Straits Settlements found a combination of the tincture of the perchloride of iron with tincture of digitalis most useful.

HÆMOPHILIA; FILARIA SANGUINIS HOMINIS.

By WALTER B. JAMES, M. D.

HÆMOPHILIA.

Synonyms.—Hemorrhagic diathesis; Hæmatophilia; German, Bluterkrankheit; French, Hæmophilie.

Definition.—An hereditary constitutional condition characterized by a tendency to severe and uncontrollable bleeding from various parts of the body, either arising spontaneously or resulting from causes which are often trivial. In some cases there are present joint lesions which form part of the disease.

History.—There is no satisfactory record of the condition in the writings of Greek, Roman, or early Arabic authors. In very early times the fact was noted that certain individuals bled more profusely than was normal after various traumata, but it was not until the present century that the existence of this tendency as a distinct disease was established.

Geographical Distribution.—The disease has been described in most of the civilized countries, and it is not possible to say that it shows a marked predilection for any race. It has been claimed that it is met with most often among the Anglo-Germanic peoples. But it is found that as the habit of scientific observation is extended the records of cases of hæmophilia among other races increase. It has also been claimed that it is especially frequent among Hebrews, but this is probably because the universal practice of circumcision among them tends to demonstrate and emphasize the existence of the malady if it is present. It is not known to occur among the lower animals.

Various Conditions.—A number of other conditions are met with in which there is a tendency to spontaneous and profuse bleeding, and from these true hæmophilia is to be carefully distinguished. Among them are scurvy in adults or in children, syphilis hæmorrhagica neonatorum, epidemic hæmoglobinuria, and peliosis rheumatica. The distinction is generally not difficult. No case is to be regarded as true hæmophilia unless the family history shows the presence of other bleeders, and unless it exhibits a constant tendency to excessive or unprovoked bleeding at all times and without reference to the general health or to the presence of any other manifestations of disease.

Sex.—The disease affects almost exclusively males, the proportion of male to female sufferers being about 11 to 1. It is also much more severe and typical in males. In females it shows itself generally only by a tendency to profuse menstruation, but it is a noteworthy fact that

among these women parturition does not seem to be attended with any greatly increased danger. Kolster found that in 130 cases of labor in women having a family history of hæmophilia the death of the mother occurred in only 3 cases, and there were only 16 miscarriages.

Heredity.—Hæmophilia more than any other phenomenon in medicine follows certain definite laws of heredity. In families of bleeders the rule is that the disease is manifested by the males, but is transmitted by the females. The father, if himself a bleeder, will generally have children who do not show the disease. But his daughters, while themselves healthy, will bear sons who are bleeders and daughters who are capable of producing bleeders. If the father is not himself a bleeder, although he belongs to such a family, he generally does not transmit the vice to his descendants. The mothers, on the contrary, whether they are themselves bleeders or not, generally bear sons who are bleeders and daughters who may transmit the condition. In some cases it is said that the disease has passed over several generations and reappeared in later descendants. There is some ground for believing that in certain families the disease with the lapse of years becomes less severe, perhaps because of the addition of new and healthy blood by marriage, and because those members who are most severely afflicted do not live to beget children. The females that transmit the disease are generally in good health. Not all the children of hæmophiliac mothers inherit the disease. A considerable number escape, but the exact proportion of these has not been satisfactorily established. Occasional exceptions have been noted to the above rules of heredity. In a few cases women had been well-marked bleeders. Cases have been noted in which the disease was transmitted directly from father to son. In a few instances several brothers have shown a decided hemorrhagic diathesis, although no evidence of hæmophilia could be detected in the ancestry. On this ground it has been claimed that the disease may originate *de novo*, and it has been thought that in these cases it was brought about by the intermarriage of near blood relations, but this has not yet been proved. Pseudohypertrophic paralysis and color blindness show the same characteristics in their heredity as does hæmophilia. Members of hæmophilic families are said to be generally of blond type and of intellectual temperament. It is pretty well established that they are more fertile than the average. In 12 families there was an average of $10\frac{1}{2}$ children each.

It is said that in bleeders loss of blood is better borne than by other individuals. Kunze claims that in these persons the hair turns gray prematurely.

Symptoms.—The first manifestations of the hemorrhagic diathesis may occur at or immediately after birth. More commonly, however, they are postponed until the first or second year. According to Grandidier, in 113 cases the bleeding began in the first year in 63, in the second year in 17, in the third year in 13. It is unusual for the first hemorrhage to occur after the tenth year. Yet in 2 cases, a father and son, the first bleeding took place in the twenty-second year. Cases have been reported in which the hemorrhages generally began in the night. The bleeding is apt to be most frequent and most severe during the winter season and in cold, damp weather, and sometimes it seems to be brought on by exposure to cold. In some cases prodromata have been

noticed. These are sometimes the signs of plethora, sometimes restlessness. In other cases attacks are preceded by unusual cheerfulness and sense of well-being. In children there may be restlessness or convulsions. There is often a tendency for the bleeding to become less severe later on in life. The bleeding is capillary oozing, the loss being steady and uninterrupted and generally absolutely unaffected by remedial measures. Clots may form, but the oozing goes on under them, and they finally become loosened. Spontaneous hemorrhages are most often from the nose. Less often there is hæmatemesis or bleeding from the bowels.

Hæmaturia occurs only rarely. There may be hemorrhages into the skin or into the subcutaneous connective tissue, forming hæmatomata often of considerable size. In many cases these, although apparently spontaneous, are probably the result of unnoticed traumata. Hemorrhages into the serous cavities have occurred fairly often.

Traumatic hemorrhages may follow any wound or injury, however slight. In one case a fatal issue followed the scratching of the side of the tongue with a toothpick. A very frequent cause is the pulling of teeth, a procedure which should never be undertaken in a hæmophilic subject. Surgical operations, however slight, expose the patient to great danger. It is said that vaccination is an exception to this rule, in that severe bleeding rarely follows it. Indeed, it has even been proposed to vaccinate the bleeding points with a view to arresting the process.

After considerable hemorrhage the blood shows the same character as under similar circumstances in healthy persons. It is pale, the hæmoglobin is diminished, the red cells are diminished, and the white cells are moderately increased in number. The bleeding may last only a few hours or it may continue for days or until the patient dies from exhaustion.

Joint Lesions.—These form a tolerably characteristic feature of the disease. The joints most affected are the knees and elbows, but any of the joints may be involved. There may be only pain or tenderness, with or without swelling, or there may be at the same time constitutional symptoms (fever and prostration), so that it resembles an attack of acute articular rheumatism. The essential feature of the joint lesion seems to be hemorrhage into the articular cavities and into the periarticular tissues. It may closely resemble tubercular disease. Following the joint disease there may finally be ankylosis and deformity. It is probable that most of the cases of joint disease in hæmophilia are the result of traumatism, these structures being especially liable to shock and jar.

Pathological Anatomy.—After death no lesions are discovered that may be regarded as characteristic of the disease: the organs are all anæmic, as in severe hemorrhage from any cause. In several cases the heart has been found to be the seat of fatty degeneration. Birch-Hirschfeld has found the epithelium of the arterioles and capillaries swollen. In some cases the arterial walls have been found unusually thin.

Pathogenesis.—The essential nature of the disease is unknown, although many hypotheses have been offered to explain it, some based upon post-mortem examination, others upon pure speculation.

Virchow claimed that there was a congenital narrowing of the blood-vessels in proportion to the total amount of blood, and so a constant overfilling of the capillaries and arterioles. Eichhorst suggests that probably there are abnormalities in the blood and in the vessel walls of a chemical nature, and which elude our methods of investigation. An interesting view has recently been advanced by A. E. Wright. He finds that hæmophilic blood clots much more slowly than normal human blood, and that it contains a diminished number of white corpuscles, especially the multinuclear forms. He ascribes the obstinate bleeding to a deficiency in the nucleo-albuminous material provided by these cells, and consequently a failure in the formation of a clot at the seat of bleeding. A somewhat similar view has been propounded by Schmidt and v. Manteuffel. Upon his theory Wright has based a plan of treatment which he claims is successful (p. 813).

Prognosis.—Only a small proportion of cases live to adult life. Grandidier states that of 181 cases, 152 died before the end of the seventh year. The disease is rarely fatal in the first year. A few cases have lived to a very old age.

Diagnosis.—In most cases the diagnosis is not difficult. The family history and a tendency to excessive bleeding, without the presence of any other evidence of disease, will usually make the nature of the trouble apparent. In some cases it is difficult to distinguish between the joint lesions of hæmophilia and those of acute articular rheumatism, especially in those cases in which there are constitutional symptoms. But here the family history, the tendency to hemorrhages, and ecchymotic discoloration about the involved joints will usually make the diagnosis possible.

Treatment.—All female members of hæmophilic families and all male members who are themselves bleeders should be advised not to marry. Bleeders should be protected as much as possible from injury, however slight. No surgical operation whatever should be attempted. They should always have the nature of their malady fully explained to them in order that they may be prepared to protect themselves. The pulling of teeth should be especially avoided. The patients should live upon a simple diet, avoiding excesses of all kinds, and they should avoid alcoholic beverages or take them only sparingly. In the treatment of the bleeding every possible device for the stopping of hemorrhage has been tried, generally without success. Pressure and styptics are of little avail. Indeed, they seem often to do harm by producing further small traumata from which additional oozing takes place. In some cases, after every effort to stop the bleeding has failed, it has ceased spontaneously when the loss of blood has reached almost the fatal point. Legg believes that the bleeding is as likely to stop if left to itself as if it is treated locally. Hayem recommends the transfusion of whole blood, believing that it operates by supplying hæmatoblasts or blood plaques, which he regards as the agents which bring about coagulation. In one case the common carotid artery was successfully tied to check the bleeding following the extraction of a tooth. The most interesting recent contributions to the treatment of hæmophilia have been made by Wright, who suggests two methods, both based upon the supposed diminished coagulability of the blood. He recommends, first, the

internal administration of the calcium salts in moderate doses, claiming that these increase the coagulability of the blood. This should not be continued, however, as in this case the coagulability becomes again diminished. Barrett of Melbourne reports a case in which, after the failure of all local treatment, the administration of liquor calcis chloridi in 1 c.c. doses was followed by a cessation of the bleeding. In this connection it is interesting to note that both Wright and Legg state that children in the families of bleeders are addicted to eating lime and plaster. They recount cases in which this passion was uncontrollable, the children in question stripping the plaster from the walls and eating it. This they regard as a physiological craving. The second plan of treatment proposed by Wright, and which he has found of service in a number of severe cases, is based upon his belief that in hæmophilia the blood is lacking in the nucleo-albuminous elements essential to fibrin formation. He advises the application of Wooldridge's tissue to the seat of bleeding, this being a solution of nucleo-albumin. It may easily be prepared with sufficient accuracy for the purpose by mincing a piece of thymus gland or testicle or gastric mucous membrane of an animal in a 1 : 500 solution of sodium carbonate. It should then be filtered and applied locally to the wound. This, he claims, produced a firm clot almost instantaneously.

FILARIASIS.

THE term *filaria* designates a group of parasites whose differentiation and zoological classification are not yet satisfactorily established. They belong to the Nematoda, and infest both man and the lower animals. The morbid state produced by the parasite is called filariasis.

FILARIA SANGUINIS HOMINIS.

The species of filaria that has been most carefully studied is filaria sanguinis hominis, of which there are supposed to be several varieties. The embryos of this parasite were first seen by Demarquay in 1863. In 1866, Wucherer of Bahia found them in the urine of a patient suffering from hæmaturia. Lewis of Calcutta found similar organisms in chylous urine in 1870, and again in 1872 he discovered the living parasite in human blood in cases of lymph-scrotum and elephantiasis. Subsequently Bancroft and Lewis found the adult parent worm in the lymphatic vessels. Recently several varieties of filaria sanguinis hominis have been described, which perhaps constitute distinct species, but we will consider first that form which is most often met with, which was first discovered and which has been most carefully studied, the filaria Bancroftii, whose embryo is called filaria nocturna.

This parasite has been met with in Africa, in India, in many of the islands of the Pacific Ocean, in South America and the most southern parts of the United States, and in the West Indies. Saussure has demonstrated its existence in Charleston, S. C., and believes that the

disease is increasing in that neighborhood. He says that it is a common malady among the dogs of that city.

Font of Barcelona has described a case that originated in Spain. This is the first case of filariasis known to have had its origin in Europe.

Natural History.—The parent worm has its habitat in man in the peripheral lymph vessels, usually of the scrotum or lower extremities. The adult male measures 83 mm. in length by about .407 mm. in breadth, or about the thickness of a human hair. The adult female measures 155 mm. in length by .715 mm. in breadth. The eggs of the female are 38 by 14 micromillimetres. The female discharges an enormous number of young filiariæ into the blood current, generally only at night, although, as McKenzie has demonstrated, if the host works during the night and sleeps through the day, the habits of the filaria are reversed and the discharge of embryos occurs during the day, so that the period of ripening accommodates itself rather to the habits of the host than to the time of day. During the night the blood of the patient is found to contain the embryo filariæ, generally in large numbers. The parasite at this stage is about 300 mm. long by 9 broad, or about the diameter of a red blood-corpuscle. It is seen to be surrounded by a delicate transparent sheath. Some observers believe that the function of this sheath is to protect it from the attacks of phagocytes in the blood. Manson, on the other hand, believes that the sheath serves to prevent the filaria from boring its way through the blood-vessel wall, in which case it would lose an opportunity of being taken into the body of a mosquito, which is necessary to the completion of its development. The middle portion of the body of the embryo is granular, the rest is translucent. The parasites in fresh preparations of blood are in very active motion, and may be seen lashing the blood-corpuscles about. If the preparation is kept until the filaria dies and becomes motionless, it grows darker and shows a transverse striation.

The accompanying figures, photographs of the living parasite, are reproduced, with the kind permission of the author, from the paper of Dr. Frederick P. Henry.[1]

Manson and many others believe that the mosquito is the intermediate host. It sucks from the patient at night blood containing the embryos, and these latter undergo partial development in its body. The insect then deposits its eggs on the water of pools, dies, and so the young filariæ find their way into the water. This latter being in turn drunk by man, the parasite when taken into the alimentary canal bores its way through the stomach or intestinal wall and seeks out its favorite situation for development, a peripheral lymph vessel. Here it remains until fully grown and produces its broods of embryos.

Bancroft does not believe that the mosquito is the intermediate host, and regards the finding of filariæ in the bodies of these insects as accidental. He believes that the complete development of the worm takes place in man without the aid of an intermediate host.

Symptoms.—Manson believes that the mere presence of the living

[1] "Report of a Case of Indigenous Parasitic Chyluria, with Filaria Nocturna in the Blood (illustrated), by Frederick P. Henry M. D., of Philadelphia."—*Medical News*, May 2, 1896.

FIG. 60.

FIG. 61.

FIG. 60.—The movement of a single filaria during a series of four successive instantaneous exposures. The length of each exposure was one fifth of a second, the entire series occupying less than five seconds. The magnification is to eight hundred diameters, with a Zeiss one-twelfth homogeneous immersion lens (Henry).

FIG. 61.—Filaria alive in the blood. Instantaneous photomicrograph. Four hundred diameters magnification. Four millimeters Zeiss apochromatic (Henry).

parasite in a situation which is normal for it gives rise to no disturbance on the part of the host, and that it becomes a source of peril and dis-

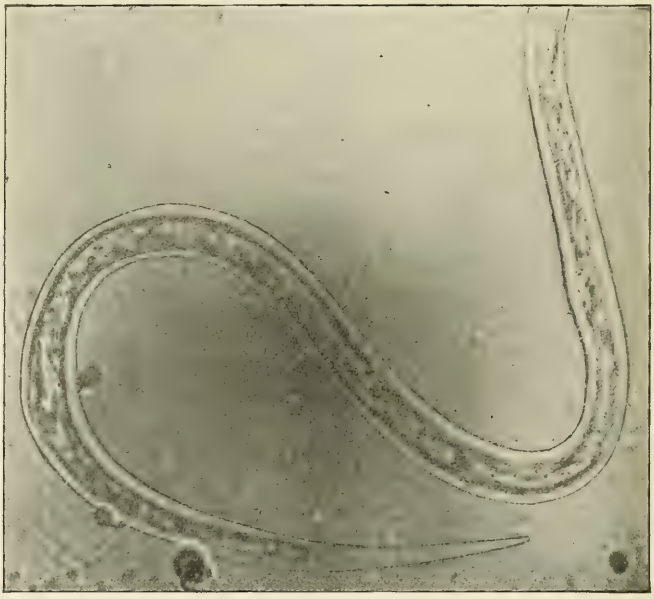
FIG. 62.

The same as Fig. 61. Magnified to fifteen hundred diameters. Showing structure and commencing grandular degeneration (Henry).

comfort only when it dies or comes to occupy an abnormal situation. Certainly in tropical countries filariæ embryos in large numbers are found in the blood of many persons who are apparently in perfect health.

The filaria manifests itself in the human body generally in one of two ways—either by the presence of blood and chyle in the urine, hæmato-chyluria, or by the production of lymphscrotum or elephantiasis. Often there are present marked constitutional symptoms. The urine when first passed is reddish white and opaque. On standing it deposits a layer of blood; the superjacent fluid is milky, with a reddish

FIG. 63.



Tail of filaria, showing sheath extending beyond the apparent end of the tail. Eight hundred diameters (Henry).

or yellowish tint. There may be a fatty layer resembling cream on the surface. The reaction is generally faintly acid or neutral. The percentage of urea is normal. There is generally a moderate amount of albumin. There is no sugar and no peptone. Microscopically, it contains fat drops of small and large size, red and white blood-corpuscles, and generally filarial embryos. Sometimes the presence of blood clots in the bladder gives rise to considerable pain on micturition. During an attack the condition of the urine varies much from day to day; the amount of chyle and blood is variable. With the attacks of chyluria there may be fever, generally not high, but sometimes well marked. There may be also headaches, backache, and malaise. The attacks of chyluria vary much in severity and duration. They may last from a few days to several months. Between the attacks the patient may feel well and void normal urine, and at these times the embryos generally cannot be found in the blood.

The elephantiasis of the lower extremities and the lymph-scrotum which are so often associated with hæmato-chyluria are persistent features, and show a tendency to become gradually more and more marked. In this lesion the tissues of the scrotum are enormously thickened and the lymphatic vessels much dilated. On puncture or incision a clear or somewhat milky fluid is obtained, and in some cases the parasite is found in this fluid. In woman a similar growth may occur in the labia majora.

Manson believes that the ova, prematurely discharged, lodge in the lymph vessels and produce a chronic lymph stasis, and, as a result of this, the above-described symptoms. He says that the parasite when it goes through its regular cycle in a normal situation gives rise to no symptoms. Firket believes that the filariæ sometimes enter the capillaries doubled up, and, being unable to pass along, act as emboli. The chyluria is probably a lymphorrhagia from the mucous membrane of the bladder. As lymph pressure is very low, obstruction to a vessel produces rupture and pouring out of lymph only on the surface of body cavities, and so the obstruction manifests itself in the acute stage only as chylous ascites and chyluria. It has been demonstrated that the chyle is not secreted with the urine by the kidneys, but is poured from the surface of the mucous membrane of the bladder. It is doubtful whether all cases of elephantiasis and lymph-scrotum of tropical countries are due to filaria, as it is not possible in every case to demonstrate the presence of the parasite. It is always possible, however, in these cases that the trouble was originally filarial, and that the parent worm has died, its body remaining and acting as the obstruction; or even that the tissue changes initiated by the organism have persisted long after the original cause of the trouble has disappeared.

Duration.—The disease may last from a few months to many years, even when the patient is removed from the country where he acquired the trouble, and the blood may for a long time exhibit embryo filariæ. Firket found them in the blood of a negro from the Congo who had been living in Belgium for six years.

Diagnosis.—The diagnosis depends upon the discovery of the organisms in the blood, and this should be examined both by day and night. It is best to use a microscope with a low power, and it is sometimes necessary to look through many specimens. In well-marked cases the embryos are readily found, there being often several in one field of the microscope. In dried blood they may be stained with eosin and glycerin.

Prognosis.—The prognosis for cure is unfavorable, although danger to life is not great. In a few cases with frequently recurring attacks of hæmato-chyluria a condition of marasmus supervenes, and the patient finally dies from exhaustion.

Treatment.—The prophylaxis is important, although from lack of exact knowledge of the life-history of the parasite we cannot be sure of covering all the ground. In countries where the disease occurs drinking water should be filtered or boiled, unless it is collected in cisterns that are not open to the air and thus inaccessible to mosquitoes.

Individuals who are suffering from filariasis should, if possible, be removed to another climate in order to avoid risk of reinfection. As to the efficacy of treatment of the disease itself opinions differ. Flint

advises methylene blue, but Laveran added this to filaria blood under the microscope, and found that the parasite continued in active movement for twenty-four hours. F. P. Henry in a recently reported case gave methylene blue in full doses for a long period, without there being any diminution in the number of embryos in the blood.

Authorities differ as to the advisability of attempting to remove the adult worm by operation. Maitland operated on a lymphangitis of the arm, removed the thickened tissue, and found in it eight specimens of adult filariæ, but the patient still continued to have embryos in his blood, thus showing that there were other parasites elsewhere in his body; but he advises against excision in cases in which there is very extensive varicosity of a considerable part of the lymphatic system or in cases where the parasite gives rise to but little inconvenience.

Other Varieties of Filaria Sanguinis Hominis.

(*a*) *Filaria diurna*, described by Manson in 1891. The embryo differs from the filaria nocturna in the absence of granules from its body and in appearing in the blood of its host only or chiefly during waking hours. Manson suggests that the filaria loa is the parent organism of this form.

(*b*) *Filaria Perstans.*—The embryos in this form are much smaller than in the preceding. The adult worm has not been found. Manson believes that this form is the cause of the so-called sleeping sickness of the negroes inhabiting certain parts of the coast of Africa.

Guinea-worm Disease (Dracontiasis).

A disease produced by the guinea-worm, dracunculus Medinensis, or, as it is sometimes called, filaria Medinensis.

Geographical Distribution.—It occurs very rarely in the United States, and then only when imported; occasionally in the West India islands; most often in the tropics of Asia and Africa. It is found in man, and also in horses and dogs.

Natural History.—Only the female worm is known. The adult measures two, three, or even four feet in length and one tenth of an inch in thickness. Its anatomy is very simple. It consists of a tube containing a uterus, within which are enormous numbers of embryos. At the head is a punctiform mouth surrounded by a crown of papillæ. At the tail is a hook which perhaps serves to attach the worm to its host. No vagina nor anus nor alimentary canal has been made out. The parasite in its embryo form is probably ingested by man in drinking water. It burrows through the stomach or intestinal wall into the connective tissue, where it undergoes further development until the uterus and contained embryos have reached a certain stage in growth, when it makes its way through the connective tissue of its host, travelling generally downward toward the feet. Finally, it reaches the surface, where it bores a small hole in the skin, and through this it expels its embryos, probably by way of its mouth. The expulsion of these takes place gradually, continuing for about two weeks. The parent worm may then either come out through the opening already made, or she may die, remain in the tissues, and give rise to suppuration.

The length of time that elapses between the entrance of the young worm into the stomach of its host and the ripening and expulsion of the embryos from the fully formed adult is from a year to a year and a half. Out of 181 cases, in 124 the worm came to the surface in the feet, in 33 cases in the leg, in 11 cases in the thigh. This partiality for the lower extremities is supposed to be due to the fact that the habitat of the embryos is water. In tropical climates the natives are barefoot, and often have the feet in water, and thus by natural selection the Guinea-worm has developed a tendency to burrow toward the feet. The embryo when free in the water finds its way into the body of a small fresh-water crustacean, cyclops quadricornis, and by means of drinking water it finally is taken into the human stomach, thus completing its cycle of growth.

Symptoms.—The ingestion of the embryo and its presence and growth in the connective tissue of its host give rise to no symptoms. The disease manifests itself only when the fully developed adult has reached the surface and is ready to discharge its young brood, when there appears under the skin a soft, movable swelling which is not painful. Following this there are congestion and some tenderness, and finally a small opening is seen through which the discharge of embryos takes place intermittently.

Generally there is but one worm, but in a few cases several have been met with in the same patient.

Diagnosis.—A diagnosis is possible only when the worm has reached the surface, and it then depends upon the character of the swelling, the history of exposure to tropical influences, and the microscopical examination of the discharge.

Treatment.—It is customary in countries where the disease prevails to wind out the worm, using a rounded piece of wood. This must be done with great care and deliberation, as otherwise the parasite is liable to be broken and suppuration ensues.

Manson recommends leaving the parent worm, believing that after the embryos have all been discharged she will then come out of her own accord. Young and others recommend killing the parasite by the injection of a weak solution of corrosive sublimate. It is said that if cold water be poured upon the limb just above the seat of trouble the worm will come out.

DIABETES; GLYCOSURIA.

By WARREN COLEMAN, M. D.

DIABETES INSIPIDUS.

Diabetes insipidus must not be confounded with those forms of polyuria which are caused by diseases of the kidneys, which occur during the absorption of serous or sero-fibrinous exudates, which are dependent upon the action of chemical or other substances (diuretics) upon blood-pressure or the renal cells, which accompany the habitual ingestion of large quantities of water or an interference with the secretion of sweat.

An increased flow of urine usually occurs during or after attacks of hysteria, and frequently as the result of emotional or other nervous excitement, and is not to be regarded as diabetes insipidus. Likewise, an increase in the quantity of urine secreted may occur during convalescence from some of the acute diseases, but, as a rule, it persists for a short time only.

Etiology and Pathogenesis.—The causes of diabetes insipidus are usually divided into (1) predisposing, and (2) exciting.

1. *Predisposing Causes.*—Age is to be reckoned, perhaps, as the most prominent among the predisposing causes. Diabetes insipidus occurs most frequently before the thirtieth year. Of 242 cases studied by Roberts, Strauss, and Van der Heijden (*v. Ziemssen*), only 64 occurred after thirty years of age. The period of greatest frequency is the third decade. The disease is by no means unknown, however, before the fifth or after the sixtieth year. A case has been reported by Dickinson in the newborn child.

Heredity has seemed an important factor in certain cases, both in the inheritance of the disease itself and the inheritance of a neurotic temperament. Remarkable instances of the influence of heredity have been recorded. Lacombe describes a family in which a mother, her three sons, and a daughter suffered from the disease, while the mother's brother and his children were similarly affected. Weil traced out the history of a family of 91 members through four generations, and found that 23 of them had diabetes insipidus.

Sex must also be considered a predisposing cause, in that males are affected more frequently than females. Of 173 cases analyzed by Roberts and Van der Heijden, 126 were males and 47 females.

2. *Exciting Causes.*—The causes here enumerated must be regarded as exciting—at least until more positive data can be obtained—only in the sense that they have immediately preceded the onset of the disease

in certain cases. With regard to the causes which lie in the nervous system, however, there would seem to be a more definite relation of cause to effect.

The disease has variously followed sudden violent emotions, such as fright, a single ingestion of a large quantity of iced water or other liquid, and a night of debauch. It has developed also during convalescence from acute diseases, as typhoid fever, after sunstroke, and in association with abdominal tumors, including aneurysm, tubercular peritonitis (Osler), and syphilis. In the case of abdominal tumors the possibility of a nerve-influence upon the kidneys, excited in the abdominal sympathetic ganglia or nerves, must not be lost sight of as a causative factor. Dickinson has reported a case in which a lesion of the solar plexus was found.

It is generally believed that disorders and lesions of the nervous system play the most important rôle in the production of diabetes insipidus. In certain cases the disease has immediately followed upon injury to some portion of the cerebro-spinal axis—cerebral hemorrhage, trauma of the head with or without fracture of the calvarium, trauma of the cord. In other instances the disease has been associated with intracranial tumors, and a few cases have occurred in epileptics. It must be stated, however, that Strümpell regards certain cases which occur with tumors or inflammatory changes in the medulla or cerebellum and exostoses at the base of the skull, not as examples of diabetes insipidus, but of sympathetic polyuria.

After all has been said, the pathogenesis of diabetes insipidus is much a matter of conjecture. The most plausible theory is that of interference with the normal working of the renal vaso-motor apparatus. It has been recently demonstrated that the kidney receives both vaso-dilator and vaso-constrictor fibres.

It is known also that the quantity of urine secreted, in terms of water, is dependent directly upon the *volume* of the blood-flow through the kidneys. Experimental stimulation of the vaso-dilator fibres causes, other things being equal, an increase in the quantity of blood supplied to these organs and an increase in the quantity of urine secreted, whereas stimulation of the vaso-constrictor fibres produces contrary results. Moreover, section or inhibition of the vaso-constrictor fibres causes vaso-dilatation and an increased blood supply.

These considerations lead to the assumption that in cases of diabetes insipidus we have to deal with the effects of vaso-dilatation, and that the causes which are operative in its production have in some way or other to do with stimulation of the vaso-dilator fibres or with inhibition or paralysis of the vaso-constrictor fibres of the kidney. From known facts of origin and distribution of the vaso-motor fibres it would be possible for a cause to act in the brain itself, in the cord above the levels of exit of the nerves containing the kidney fibres, or somewhere in the course of the fibres after they have left the cord.

The influence of emotions in increasing the flow of urine in health, and the influence of such nervous disorders as hysteria, tend to show that actual structural lesions of the vaso-motor nerve tracts are not necessary for the production of the disease—that it may sometimes arise after the manner of neuroses. Such a theory would explain those

cases in which no structural lesion could be found to account for the disease.

Symptoms.—There are two chief symptoms of diabetes insipidus—the secretion and passage of large quantities of urine, and excessive thirst.

The onset of the disease may be abrupt or insidious. It is abrupt generally in those cases which follow injuries to the cerebro-spinal axis, excessive indulgence in the drinking of iced water or alcoholic beverages (*vide* Etiology, p. 822), and emotional excitement, such as fright. On the other hand, cases which occur in association with chronic affections of the brain or cord, intracranial tumors, or other chronic conditions are likely to be insidious in their onset, the quantity of urine becoming more and more increased and the thirst more and more pronounced.

The quantity of urine secreted varies very much in different cases, and may vary in the same case at different times. This quantity is in close accord with the quantity of liquid ingested. It has varied in different cases from a few pints above the normal to as much as 40 quarts in the twenty-four hours. It usually runs from 8 to 10 quarts. From a pint to a quart may be evacuated at each micturition. If the bladder be irritable, not so much urine will be collected between the acts of micturition, and a smaller quantity will be passed at more frequent intervals. The frequent necessity to empty the bladder constitutes a very inconvenient symptom.

The urine is very light in color, almost like water, and often possesses a greenish hue. It is feebly acid or neutral in reaction. Its specific gravity is rarely above 1010, and may be as low as 1001. The low specific gravity is dependent upon the great dilution of the urine. For the same reason the solid constituents are relatively diminished, although actually they are slightly increased. This increase is thought to be due to the more thorough "washing out" of the tissues by the large amount of water which passes through the body. The total quantity of solids corresponds with the quantity and quality of the food. In the case of urea, however, the daily excretion is in excess of that of a healthy person consuming the same amount of nitrogenous food. The total excretion of calcium, creatinin, sulphuric and phosphoric acids is said to be increased.

The urine does not, as a rule, contain any abnormal ingredients, though both albumin and sugar may be found in rare instances. In these cases the presence of the abnormal ingredient is not due to the disease itself, but to some other cause—probably alimentary glycosuria on the one hand and physiological albuminuria on the other. If either is constantly present, then the disease is not diabetes insipidus. Cases of diabetes insipidus have been reported which developed into diabetes mellitus, and in which the occasional appearance of sugar perhaps foreshadowed the transition. Inosit, or muscle sugar, is sometimes found in the urine, but, so far as is known, its presence is without significance.

The thirst is excessive and distressing. Large quantities of liquid have to be drunk to compensate for the loss of water through the kidneys. So urgent is the thirst at times that patients have been known to drink freely of their own urine. The total quantity of liquid taken in twenty-four hours is slightly in excess of the urine voided in that time.

The ingestion of large quantities of water by the diabetic is not so soon followed by an increased flow of urine as is the case in healthy adults.

The secretion of saliva is diminished. The mouth is dry, and this condition undoubtedly adds to the insatiable thirst. Likewise, the secretion of sweat is decreased, and in consequence the skin becomes dry and harsh.

The appetite is normal—in marked contrast to what is sometimes seen in diabetes mellitus—and there are no gastro-intestinal symptoms directly referable to the disease itself, unless it be constipation from dryness of the fæces. Sometimes diarrhœa occurs. The temperature may be subnormal. Patients suffering from diabetes insipidus are not so subject to cutaneous, pulmonary, and other complications as are patients with diabetes mellitus. Though pulmonary tuberculosis is not common, it does occur in some cases. Diabetes insipidus is not known to predispose to any complication. Since the disease is one of such long duration, however, it would be remarkable if complications were not occasionally met with.

The intercurrence of acute diseases usually causes a temporary abatement in the symptoms of diabetes insipidus, and it may even disappear entirely after convalescence from them.

Course.—Diabetes insipidus is a disease of long duration. Cases which run a comparatively rapid course, however, occur. This fact may be explained in certain instances by the fatality of the lesion which has caused the diabetes. In other cases an equilibrium, so to speak, becomes established, and the disease persists for years without appreciable alteration in the condition of the patient. It has been known to persist for fifty years. In still other cases, even where the primary cause would not shorten life or where no cause can be found, the patients grow weak and languid and are indisposed to bodily or mental exertion. Such cases as have been reported as cured have lasted from a few months to as many years.

Prognosis.—The prognosis as to the continuance of life is favorable in most cases; as to the cure of the disease, unfavorable. The tone of the renal vessels is rarely regained when once the disease is established. The determination of the cause of the disease may affect the prognosis. Thus Strümpell states that he has seen cases of syphilitic origin improve under antisyphilitic treatment. If, on the other hand, the disease is caused by a demonstrable lesion of the nervous system, which lesion is known to shorten life, the prognosis must be unfavorable. In no case should a promise of improvement be held out. Cases do occasionally improve, however—some under treatment, others without assignable cause.

Diagnosis.—The diagnosis of diabetes insipidus usually occasions but little difficulty. In a case which presents continuously the two prominent symptoms of insatiable thirst and secretion of large quantities of urine of low specific gravity, not containing any abnormal ingredient, it is scarcely possible to mistake the disease. The only diseases with which diabetes insipidus is likely to be confounded are chronic interstitial nephritis and diabetes mellitus, and in either case a thorough examination of the urine will serve to differentiate them. It must be remembered, however, that albumin and casts may disappear from the

urine from time to time in chronic interstitial nephritis, and hence more than one examination may become necessary.

TREATMENT.—Diabetes insipidus is an incurable disease, though sometimes it has disappeared as mysteriously as it developed. This result, however, cannot be attributed to treatment. The results of treatment are very unsatisfactory.

If the cause of the diabetes can be discovered and is removable, appropriate measures should be adopted. This pertains more particularly to cases of syphilitic origin. Distinct benefit has followed antisyphilitic treatment.

Ordinarily, a slight improvement in the patient's condition—a slight diminution of the thirst and of the quantity of urine secreted—is all that can be hoped for. On the theory that the disease is due to renal vaso-motor disturbance, from whatever cause, ergot, ergotin, and electrical stimulation of the kidney region have been advocated, but it is doubtful if much good results. The ergot should be given in large doses three or more times a day, or one pole of a faradic battery may be placed over the kidney and the other on the spine higher up. The current should be applied daily for fifteen minutes or half an hour. Trousseau found valerian useful in gradually increasing doses—from 15–30 gr. to as much as 3ʒ in the twenty-four hours, given in broken doses three times a day. Opium, morphine, and codeine may lessen the thirst and diminish the amount of urine in certain cases, but they are objectionable on the grounds that they may upset digestion and that the opium habit may be formed. Various other drugs have been recommended, such as tannic acid, the salicylates, potassium bromide, etc., but they have been used with only partial success.

Such other treatment as may be instituted can only be regarded as symptomatic, and as directed to relieving the thirst or promoting a healthy action of the skin. To these ends bits of ice may be held in the mouth or acid drinks be given and warm baths be advised. After the bath the skin should be rubbed with a coarse towel. It must be remembered, however, that warm baths may depress the patient. Moreover, it is better to take them at night to avoid exposure. In no case should liquids be withheld from the patients, though the quantity allowed them may be diminished.

GLYCOSURIA.

IT is not intended that the separate classification of the milder forms of glycosuria shall be taken to mean that they are essentially different in nature and origin from the graver forms of diabetes mellitus. The question of the unity of all forms of glycosuria does not come within the scope of the present article. The classification has been adopted for clinical reasons only—to emphasize the fact that the presence of sugar in the urine is not necessarily indicative of diabetes mellitus.

Transient Glycosuria.

Definition.—Transient glycosuria may be defined as the temporary appearance of glucose or grape sugar (dextrose) in the urine, usually in small quantity.

Cane sugar, alone or associated with grape sugar, may appear in the urine when ingested in large quantity, and the condition is called *saccharosuria.*

The presence of milk sugar in the urine is termed *lactosuria.*

The presence of lævulose in the urine is termed *lævulosuria.*

When sugar appears in the urine it is derived as such from the blood. Normally, the blood contains a small but constant proportion of sugar, 0.1 to 0.2 per cent., and when this amount is exceeded (hyperglycæmia) there is an overflow into the urine. It is Nature's method of restoring the blood to its normal composition. Bouchard states that glycosuria occurs when there is more than 4 to 6 grammes of sugar per kilogram of blood.

Authorities are not agreed as to whether normal urine contains a trace of sugar. But even those who contend for its presence state that the quantity is so small that it does not respond to some of the most delicate tests. If the urine be concentrated by evaporation before the tests are applied, faint reactions of sugar may be obtained. Hence for practical purposes we may assume that healthy urine is free from sugar.

Etiology.—The causation of the majority of cases of transient glycosuria is involved in obscurity, and will remain a matter of conjecture until the disposition of sugar in its entirety in the organism, and the control of this disposition, become known. Certain steps in the disposition of sugar, however, are known, which will permit the building of theories upon them. But it must be understood at the outset that many statements in the following discussion will be merely tentative.

Transient glycosuria is a symptom of some temporary interference with the usual disposition of sugar in the organism or of its excessive ingestion. In considering its etiology it will be found convenient to recognize the following varieties: (1) Alimentary, (2) Toxic, and (3) Forms associated with diseases and injuries.

Alimentary Glycosuria.—The sugar (dextrose or dextrose and lævulose) which reaches the liver from the stomach and intestines through the portal vein is converted by the activity of the hepatic cells into glycogen, and is stored in them for the future needs of the body. Thence it passes out, a little at a time, reconverted into sugar (dextrose), into the general circulation. This, in brief, is the glycogenic function of the liver. Within varying though wide limits the liver can dispose of only a given quantity of sugar, and when more than this amount is carried to it, or when the glycogenic function is temporarily depressed, the excess passes into the hepatic veins unchanged, producing hyperglycæmia and glycosuria. It is in this manner that alimentary glycosuria arises, and it is not of infrequent occurrence in persons who indulge to excess in starchy and saccharine foods. In fact, Brunton states that if the urine of several healthy persons be examined about two hours after breakfast it is probable that sugar will be found, since breakfast

is a meal consisting largely of carbohydrates, and at which large quantities of saccharine substances are frequently taken.

The excessive ingestion of cane sugar produces saccharosuria, associated, in the majority of instances, with glycosuria. Cane sugar, grape sugar, and milk sugar, taken in quantities of 50 to 250 grammes, pass directly into the urine, causing temporary glycosuria (Worm-Müller). Lævulose when taken in large quantities is excreted in the urine (lævulosuria). These statements are in accord with the recently published results of Linnoissier and Rogue, who experimented upon 19 healthy individuals. They found also that cane sugar passes more readily into the urine than grape sugar, and grape sugar than milk sugar.[1] Active elimination does not begin until one hour after ingestion; the maximum is reached from the second to the fourth hour, and the sugar disappears within eight hours.

The lactosuria which is present at times in pregnant and nursing females must be classed under the heading *alimentary*, since it occurs because the milk sugar which is formed in the breast is reabsorbed into the circulation. It occurs most frequently when the secretion of milk is arrested: if the flow is abundant, sugar is not found, or but rarely. Hoffmeister has detected sugar in the urine of infants fed exclusively upon milk, and it is found at times also in the case of babies living on prepared foods containing large amounts of soluble starch. Glycosuria is especially likely to occur in nursing infants with digestive derangements (Grosz).

Toxic Glycosuria.—This term will include those conditions of the urine which occur not infrequently after the administration of certain remedial agents in which either sugar itself is present or some substance which responds similarly to many of the tests for sugar, and which might thereby lead to erroneous deductions. The subject presents a wide field for research. Definite statements are wanting as to the manner in which many of these agents produce glycosuria, or, for that matter, whether they produce glycosuria at all.

It has been variously supposed that under the action of certain of them the glycogen in the liver and some other tissues of the body is converted more rapidly than normal into sugar, either by direct action upon the cells or through the medium of the nervous system; or that some body which is not glycogen is converted into sugar; or that the kidney cells are so affected that they fail to hold back the sugar which is normally present in the blood; or, again, that the tissues lose their power of appropriating the sugar brought to them, and that, in consequence, it accumulates in the blood, to be excreted in turn by the kidneys. On the other hand, Halliburton and others contend that the reducing agent in the urine is not sugar, but glycuronic acid or some combination of glycuronic acid or some other compound. It seems well assured that in certain instances the reducing agent is not sugar. Chloroform, chloral, and arsenic *per se* reduce Fehling's solution.[2] Chloroform

[1] Howell states, however, that the limit of consumption of milk sugar is soon reached in the human adult, and that it readily passes into the urine unchanged (lactosuria).

[2] At my request, R. J. J. de Roode, Ph. D., has kindly determined the reactions of the following substances with Fehling's solution, with the results given below: Chloroform, chloral, and arsenic (arsenous acid) positive; ether, amyl nitrite, turpentine, morphine, sulphuric acid, alcohol, carbon dioxide, and strychnine, negative. In the case of the

and arsenic are excreted as such in the urine. It is probable that the glycosuria reported as occurring after their administration is the result of faulty observation. Moreover, glycuronic acid is present in the urine after chloroform narcosis, which in itself reduces Fehling's solution. Chloral is rarely found in the urine or occurs only in traces. It is eliminated as urochloralic acid. This acid, however, will reduce Fehling's solution.

After the administration of morphine and curare the urine contains glycuronic acid.

The urine of patients taking turpentine often possesses the property of reducing Fehling's solution and responding to other tests for sugar. These reactions are due to the presence of turpenglycuronic acid (Haussman). Quincke states that the urine of patients taking copaiba will reduce Fehling's solution, but that it will not respond to the bismuth test for sugar.

After the administration of acetanilide a complex phenol compound is eliminated which responds to the Fehling and certain other tests for sugar.

Salicylic acid is excreted in the urine as sodium salicylate and salicyluric acid, the latter possessing the property of reducing Fehling's solution.

The urine of patients taking sulphonal may at times reduce Fehling's solution, but other tests for sugar fail (Lafon).

The following substances are stated to produce actual glycosuria as a result of their action in the body: ether by inhalation, amyl nitrite, mercury, hydrocyanic acid, sulphuric acid, alcohol, strychnine, glycerin, and nitrobenzol. In two cases of asphyxia from breathing a mixture of carbon dioxide and nitrogen Von Jaksch found sugar in the urine. Phlorizin produces temporary glycosuria by causing such changes in the renal cells that they are no longer able to hold back the sugar normally present in the blood (Von Mering).[1]

It has recently been observed that the exhibition of thyroid extract may cause glycosuria.

Glycosuria frequently occurs among those who have worked long in lead, probably from the direct action of the lead on the hepatic cells (Brunelle).

Glycosurias Associated with Diseases and Injuries.—All forms of transient glycosuria which are met with during the course of or following general diseases, or which result from injuries, derangements, or diseases of the nervous system, will be included under this heading.

Von Mering has shown by direct examination of blood of the portal vein that the sugar formed from the carbohydrates in the alimentary tract is absorbed by the bloodvessels under normal conditions. In cases of portal thrombosis glycosuria occurs if there is any digested starch in the intestine. The glycogenic function of the liver is not called into

salts of mercury, mercuric oxide, which is red, is precipitated, but none of the copper is reduced. When hydrocyanic acid is added to Fehling's solution and the mixture boiled, the solution is decolorized, but no precipitate formed. The minimum amounts of chloroform, chloral, and arsenic, which give a slight reaction with Fehling's solution, are about 2 c.c. of solutions containing from 0.1 to 0.15 per cent. of these substances.

[1] Prauswitz contends that the glycosuria results from over-production of sugar (*Zeitschrift für Biologie*, Munich, vii. p. 168, 1894).

play, the sugar passes through vessels other than the portal into the general circulation unchanged, and is excreted by the kidneys. Glycosuria does not, as a rule, occur in phosphorus-poisoning. Von Jaksch, however, has found it in four cases, and the amount of sugar was in accord with the extent of destruction of the liver parenchyma. Likewise, glycosuria may be a symptom of acute yellow atrophy.

According to Hoffmeister, the function of sugar assimilation may be depressed in certain diseases, so that when sugar is taken as food, either in its own form or as a carbohydrate, it appears temporarily in the urine. This happens especially in hepatic fibrosis (Moritz, Krauss, Ludwig). A similar depression of sugar assimilation, either on the part of the liver or other glycogen reservoirs, is supposed to account for the transient glycosuria which is met with in certain obese individuals. Transient glycosuria may occur at times as a result of digestive derangements and in chronic gastritis (Frerichs). It is also met with in rare instances in diseases of the heart and lungs. Sugar sometimes appears in the urine of the aged without other symptoms (DaCosta).

Transient glycosuria not infrequently occurs in the course of, or following, many of the infectious diseases. Thus sugar may be found in the urine in cerebro-spinal meningitis, Asiatic cholera, typhoid fever, typhus fever, relapsing fever, diphtheria, tetanus, pneumonia, and pulmonary tuberculosis. According to Burdel, sugar is found uniformly in the urine during paroxysms of malarial fever, while it disappears during the intervals. Rotch states that he has met with transient glycosuria in infants suffering from scarlatinal nephritis, and that the glycosuria disappeared as the nephritis improved. Transient glycosuria occurs occasionally after asthmatic paroxysms and attacks of whooping cough. An explanation of the appearance of sugar in the urine in these diseases has not been offered.

Sugar is occasionally met with in the urine in diabetes insipidus, under which circumstance its presence is probably to be explained as an alimentary glycosuria. Ord states that transient glycosuria is not of infrequent occurrence in persons presenting in typical form the symptoms of chronic interstitial nephritis, and that it is also sometimes associated with angina pectoris.

The frequent occurrence of intermittent glycosuria in gouty individuals will only be mentioned in this connection, though, according to Duckworth, the majority of these cases do not deserve to be classed as diabetes mellitus. The subject will be considered at greater length under Diabetes Mellitus (p. 834).

Temporary glycosuria has been reported as occurring in the early incubative stages of syphilis. (See Etiology of Diabetes Mellitus, p. 837.)

Transient glycosuria may occur after many injuries to the nervous system, and at times in association with many nervous diseases. It was shown by Claude Bernard that puncture of the floor of the fourth ventricle in the region of the vaso-motor centre causes the appearance of sugar in the urine. The details of the experiment cannot be given in this place. The glycosuria is of temporary duration, the urine returning to the normal within a day or two or even shorter period, and

is believed to be caused through the agency of nerves regulating the glycogenic function of the liver, and not through vaso-motor influences (Foster).

Von Jaksch has concluded, from a long series of researches, that transient glycosuria is a constant symptom of some functional neuroses, such as Charcot's grand hysteria and the traumatic neuroses. In fact, he believed that this symptom might be of value as a means of differentiating traumatic neurosis from simulation.

Among other abnormal conditions of the nervous system in which glycosuria may occur, we find the following: Cerebral hemorrhage from external violence or other causes; hemorrhage into the pons Varolii and spinal bulb; cerebral softening, cerebral tumors, cerebral parasites, cerebral abscess; disseminated sclerosis; concussion of the brain; injuries to the vertebral column; epilepsy, insanity; neuralgia generally; sciatica; hysteria, severe psychical derangements, mental emotion; and exophthalmic goitre.

In cases of hemorrhage the amount of sugar in the urine will vary from a few grammes to more than one hundred grammes per day, it being in accord with the intensity of the shock and the location of the injury (Lancereaux). Higgins and Ogden [1] state that the sugar may appear as early as six hours after the hemorrhage, and disappear within twenty-four, the average time for its appearance being from eight to twelve hours, and for its disappearance from the fifth to the ninth day. In some cases the appearance of the sugar is much delayed. Brouardel has reported a case in which it did not appear for many months. Sometimes the glycosuria persists for four or five months. It should be stated here that certain lesions of the nervous system may produce a permanent glycosuria, accompanied by all the symptoms of diabetes mellitus.

Transient glycosuria does not present a demonstrable lesion except in rare cases—*e. g.* in the nervous system, and even here the lesion cannot be regarded as characteristic.

Symptoms.—The majority of cases of transient glycosuria present no symptoms beyond the presence of sugar in the urine, and this is often discovered accidentally. The quantity of sugar present is usually small, of occasional occurrence, and short duration. Cases are met with, however, in which the quantity of sugar is moderately large, its presence of considerable duration, and in which other symptoms present themselves, as polyuria and polydipsia. Such cases are especially likely to occur after injuries to the nervous system and in gouty and obese individuals, and from the standpoint of prognosis and treatment it is advisable to regard these cases as genuine diabetes mellitus. Sometimes diabetes has its origin in these beginnings.

The diagnosis of transient glycosuria rests upon the temporary and occasional presence of sugar in the urine. The mere presence of sugar in the urine does not justify the diagnosis of diabetes mellitus. It is quite as important to distinguish this transient appearance of sugar from true diabetes as it is to distinguish functional albuminuria from the albuminuria which accompanies organic changes in the kidneys. The one is evidence of perverted function, the other of disease. When the

[1] *Boston Med. and Surg. Journ.*, Feb. 28, 1895.

amount of sugar is moderately large, its presence more or less constant, and the symptoms sufficiently urgent to attract the patient's attention, opinion should be withheld until the case can be studied thoroughly from a dietetic standpoint. Transient glycosuria always yields to treatment; the milder forms of diabetes may, the severer forms do not. Transient glycosuria is not accompanied by symptoms as a rule, and if symptoms are present they are mild. In all cases where there is any doubt as to the nature of the affection after all the facts have been taken into consideration, it will be advisable to make a diagnosis of diabetes mellitus.

Transient glycosuria hardly deserves a PROGNOSIS. In cases which are on the border-line between it and diabetes mellitus a guarded prognosis should be given until the effects of treatment can be observed. If the sugar disappears readily from the urine and does not readily return, a favorable prognosis may be given.

Unless the glycosuria assumes a permanent nature, no TREATMENT will be demanded. Where, however, slight excesses in carbohydrate and saccharine foods lead to the reappearance of sugar in the urine, the patient should be confined to a restricted diet. (For details of the regimen see p. 857.)

DIABETES MELLITUS.

DEFINITION.—Diabetes mellitus is a disease of nutrition, sometimes acute, generally chronic, characterized by the constant presence of grape sugar (dextrose) in the urine.

The great clinical differences in the various cases of diabetes mellitus make it difficult to frame a definition that will cover all cases.

ETIOLOGY.—*Frequency.*—Diabetes mellitus is not an uncommon disease. Statistical tables show that it is increasing in frequency. Such an increase within recent years cannot be entirely explained upon the fact that more frequent and thorough examinations of the urine are made. This factor must be taken into consideration, however, since urine-analysis has become part of the routine of every physician's work. Sen,[1] in studying the increased frequency of diabetes mellitus among the educated inhabitants of Bengal, has compared the mortality from the disease there with the mortalities in Paris, England, Wales, and the United States. He states "that the disease is on the increase throughout the civilized world, and in Bengal to an extent unknown elsewhere." This statement is sanctioned by Lepine. The causes of this increase have not been entirely explained, though a multiplicity of factors seems to be at work—*e. g.* higher education among all classes, keener competition in intellectual pursuits, and increase of wealth. Worms states that in Paris diabetes mellitus has become very common of late years: the severe form which alone figures in statistical tables, caused 301 deaths in 1892, as against 136 in 1883.

Heredity is an important element in predisposition to diabetes mellitus.

[1] *Indian Med. Gaz.*, Calcutta, July, 1893, and *Brit. Med. Journ.*, Oct. 21, 1893.

About one third of the reported cases have occurred in individuals who have inherited the disease from some direct or collateral ancestor. Heredity plays a more important rôle, perhaps, in the diabetes of children than in the case of adults. Diabetes mellitus may occur in successive generations of a family or in several members of a single generation. The influence of heredity is shown not only in the inheritance of the disease itself, but in the inheritance of a neurotic temperament, neuroses, nervous diseases, or of gout or obesity. *Race* also may be classed under Heredity: the disease is more common among the Jews than any other people.

Sex.—Among adults, males are affected more frequently than females, almost in the proportion of 3 to 1. According to Kuhl, the reverse is the case in children; girls are affected more frequently than boys, though not in the same proportion.

Age.—Diabetes mellitus may occur at any age. It is rare, however, in children and in persons past sixty. In an analysis of 2115 cases Schmitz found the period of greatest frequency between thirty and sixty years of age. In women the disease occurs most frequently between the ages of twenty and forty. Stern has reported the case of an infant apparently born with diabetes, and W. H. Deane the case of a child three weeks old who died in diabetic coma.

Children of the better classes are affected more often than children of the poor.

Traumatism is often the direct exciting cause of diabetes mellitus in children (Kuhl).

Occupation.—Diabetes mellitus prevails with greatest frequency among wealthy and educated persons. All occupations necessitating continued and excessive mental application or nervous strain and excitement predispose to the disease. Consequently, diabetics are chiefly found among scientists, professional men, merchants, etc. The combination of intellectual labor or nervous strain with sedentary habits is considered especially harmful. Sen[1] calls attention to the increasing prevalence of diabetes mellitus among middle-class Bengalis who earn their livelihood by brain-work, and considers one of the factors of this increase the high educational pressure of the day.

Worms[2] found sugar in considerable amount in 7 instances in examining the urine of 100 male brain-workers leading sedentary lives. On the other hand, sugar was not found in a single instance among 607 artisans and laborers.

One of the reasons why diabetes mellitus more commonly affects men than women lies undoubtedly in the fact that they follow intellectual pursuits more generally and more actively.

Indiscretions in Diet.—We have seen that a transient glycosuria may occur in healthy persons from over-indulgence in starchy and saccharine foods, but it is doubtful if such indulgence ever induces a severe form of diabetes mellitus, except in those predisposed to the disease from other causes. In certain cases of gout and obesity the continued use of sweets and starches, even in moderation, may cause a transient—at least intermittent—glycosuria to become permanent, but the symptoms of the graver forms of diabetes rarely occur.

[1] *Loc. cit.*

[2] *Bull. de l'Acad. de Méd. de Paris,* Dec., 1893.

Cantani's belief that diabetes may be produced by over-indulgence in carbohydrate foods is not generally accepted. It is objected that diabetes occurs most frequently among the wealthy classes, who live upon a mixed diet, rather than among the poor, who subsist almost, if not entirely, upon carbohydrate foods.

Yet the frequent association of diabetes mellitus with gout leads us believe that dietetic indiscretions, when combined with a sedentary life, may be a factor in its production. Sir Dyce Duckworth says: "The same habits lead to each, the same classes of persons are affected, and the same exciting causes are potent to evoke each." It should be stated, however, that he does not believe the glycosuria which so frequently occurs in gouty persons to be diabetes mellitus in the strict sense of the term.

The influence of diet, then, in the causation of diabetes mellitus is a moot point. In explanation of the cases which have been thought to arise in this manner, it is believed that the liver becomes exhausted from overwork, and that part of the alimentary sugar passes into the blood unchanged, to be in turn excreted by the kidneys.

Psychic Causes.—Psychic impressions have so often immediately preceded the onset of diabetes mellitus in carefully recorded cases that they have come to be looked upon as an exciting cause of the disease. Thus the disease has immediately followed such emotions as fright, joy, anger, or anxiety. It has followed also protracted periods of grief or care. Senator refers in this connection to the period of engrossing stock speculation in Berlin after the Franco-Prussian War, when a marked influence was exerted upon the frequency of diabetes. Intense psychic impressions may cause a return of the symptoms of diabetes after they have abated.

High-strung, excitable persons are believed to be more prone to diabetes than those of phlegmatic nature.

An interesting observation upon the influence of psychic causes on the development of glycosuria has been made on the dog by Gibier.[1] The animal, a female of timid, jealous disposition, was usually kept caged with others. Her urine normally was free from sugar. For a reason she was placed in solitary confinement. She became restless and uneasy. Two or three days afterward sugar appeared in her urine, and disappeared immediately when she was returned to her companions. She was then purposely isolated several times. In each instance the psychic disturbance occurred and the sugar reappeared, to disappear immediately when the isolation was discontinued.

Lesions of the Nervous System.—A causative relation undoubtedly exists between lesions of the nervous system and diabetes mellitus. Attention was first directed to this relation by the famous discovery of Claude Bernard of the so-called "diabetic centre" in the spinal bulb. As a general rule, the lesion affects the cerebro-spinal axis, though injuries to the sympathetic system, particularly the abdominal sympathetic, have been reported as the determining cause of the disease. In some cases no actual lesion has been demonstrable, at least so far as the symptoms have been concerned: the disease has followed concussions.

[1] *Compt. rend. Hebdom. des Séances de l'Acad. des Sciences,* Paris, Apr. 23, 1894.

The lesion need not necessarily be situated in the region of the spinal bulb in order to cause diabetes. The lesions which diabetes has followed are—cerebral hemorrhage (apparently causative irrespective of the part of the cerebrum involved); syphilitic affections of the brain, especially of the spinal bulb (E. D. Fisher); hemorrhage into the fourth ventricle (Mallet); cysticerci in the floor of the fourth ventricle (Osler); focal hemorrhages into the bulb (Frerichs); brain tumors; injuries to the abdominal sympathetic ganglia or nerves; organic disease of the peripheral nerves (Strümpell). Diabetes has also followed functional nervous diseases.

Lesions of the cerebro-spinal axis or sympathetic system are not by any means followed in every case by diabetes mellitus or even a transient glycosuria. A theory to account for the production of glycosuria by these various lesions of the nervous system will be considered under the Pathogenesis of Diabetes Mellitus (p. 839).

Bernstein-Kohan [1] has made a study of the relation of traumatism to diabetes mellitus in 45 cases. He concludes that diabetes most often follows traumatism of the head (in 25 of the 45 cases); that sugar does not always appear in the urine immediately after the injury; that the earlier the appearance of the sugar the milder the diabetes, and, on the contrary, the later its appearance the severer the diabetes; that radical cures are not infrequent (in 14 of the 45 cases); and that recovery seldom occurs where the diabetes has persisted for more than six months or a year.

Some authors, notably Schnée, have claimed that all cases of diabetes are primarily referable to affections of the nervous system. This claim is too far-reaching, and cannot be maintained in the face of the opposing evidence.

The quantity of sugar in the urine may vary very much. The duration of its presence also varies. All grades of glycosuria, from the most transient form to a grave diabetes, may be met with as the result of some lesion in the nervous system.

Insanity.—Mention must be made of the association of diabetes mellitus with insanity. Savage [2] calls attention to the following relations between the two diseases: that the insane may have diabetic ancestors or other relatives (in 40 cases which had come under his observation); that diabetes and insanity occurred in the same families; that diabetes might alternate with insanity in different generations, insanity appearing in one, diabetes in the next; and that one or more symptoms of diabetes might be replaced by mental symptoms. Such association appears to be more than a mere coincidence.

Gout.—"No fact in practical medicine is better established than the dependence of a variety of glycosuria on the gouty habit of body" (Duckworth). Prout observed this relation as early as 1843, and stated that many gouty and dyspeptic persons lived for years with a more or less persistent glycosuria, of which they were not conscious until an increase in the quantity of urine occurred.

Gouty glycosuria does not appear generally until toward the middle period of life. It is more likely to develop in irregular or the so-called suppressed types of gout. The patients are usually well developed and

[1] *Thèse de Paris*, 1891. [2] *London Lancet*, Nov. 29, 1890.

corpulent. Active manifestations of gout and glycosuria do not coexist at the same time. When glycosuria appears, the tendency to paroxysmal joint attacks ceases. When the glycosuria disappears gouty symptoms often reappear, such as eczematous eruptions or pains in the joints. A glycosuria which distinctly alternates with symptoms of gout is called *diabetes alternans*. Pavy has called attention to the fact that when cases of gouty glycosuria are brought under control by dietetic or other measures a copious deposit of urates occurs in the urine. Such a deposit of urates is regarded as a favorable symptom so far as the glycosuria is concerned.

Glycosuria is rarely associated with rheumatoid arthritis (Duckworth, Ord, Garrod, Charcot).

The frequency of gouty glycosuria may be gathered from an analysis of 600 cases of diabetes by R. Schmitz[1] with reference to this point. In 45 of them the glycosuria was directly attributable to this cause, and in each of the 45 gouty symptoms had existed in various forms long before the appearance of the glycosuria. Males are more often affected with gouty glycosuria than females, for the reason that they more frequently suffer from gout.

The influence of heredity upon the development of glycosuria in gouty subjects is marked. Some members of gouty families may develop gout, while others develop diabetes, or gout may appear first, to be followed by diabetes.

Sir Dyce Duckworth believes that gouty glycosuria is dependent at first upon a "disturbance wrought locally in the liver by the gouty influence," but that "in confirmed cases there is not improbably established a central neurosis which persistently dominates the whole course of the malady." Ord has suggested that a veritable gout of the liver may occur accompanied by hyperæmia and high tension. Haig states that glycosuria in the gouty is the result of congestion and high blood tension in the liver, induced by an excess of uric acid in the blood (uricacidæmia). Haig bases this statement upon the facts that gouty glycosuria alternates with other manifestations of gout, and that during active paroxysms of gout the amount of uric acid in the blood is diminished. Glycosuria, then, and active manifestations of gout correspond to opposite conditions of the blood.

According to this theory, the development of glycosuria in any case of gout depends upon an excess of uric acid in the blood with hepatic congestion. If the theory is true, glycosuria must be of much more frequent occurrence in persons affected with gout than is commonly supposed. The fact that a copious deposit of urates occurs in the urine when gouty glycosuria has been brought under control certainly lends weight to the theory. The theory also explains in a measure why the same habits of life, the same occupations, the same dietetic indiscretions may lead both to gout and glycosuria.

Although the glycosuria which occurs in gouty individuals can scarcely be considered true diabetes mellitus, it has been thought best to discuss the subject in this connection, for the reasons that it is more or less persistent, and that in rare instances it passes into the graver form. Gouty glycosuria is not a grave affection, and yields readily, as

[1] *London Lancet*, Nov. 4, 1882.

a rule, to dietetic and other treatment. It may persist for years intermittently—that is, alternating with more or less characteristic attacks of gout—without appreciable alteration in the condition of the patient. Oftentimes the first indication of its existence is an accidental discovery of the presence of sugar in the urine. On the other hand, mild symptoms may present themselves, such as an increase in the quantity of urine, increased frequency of micturition, an unusual, though not immoderate, thirst, and, in the case of women, a persistent itching of the vulva.

The quantity of sugar in the urine varies very much in different cases and in the same case at different times.

Obesity.—The relation between obesity and transient glycosuria has been referred to already. This glycosuria is at times undoubtedly of alimentary origin—that is, the result of over-ingestion of starchy and saccharine foods. In other cases the relation is of a more profound nature, and the glycosuria is dependent upon faulty action of the liver or perverted metabolism in the tissues.

Diabetes when occurring in the obese is generally called "*lipogenous.*" Von Noorden has suggested the term "*diabetogenous obesity*" as more accurately descriptive of the condition. He holds that certain obese individuals, though they do not excrete sugar through the kidneys, are in reality diabetics—that there is an excess of sugar in their blood, but that, instead of the sugar's passing out through the kidneys as waste, it is converted into fat. "The obesity masks the diabetes." Upon this theory the diabetic habit, so to speak, antedates the appearance of sugar in the urine.

Diabetes rarely appears in corpulent persons before the fortieth year. It is almost always mild in character, and yields readily to treatment. In certain cases, however, the mild may pass into a grave form, accompanied by gradual loss of fat and actual emaciation. Generally the fat and the diabetes persist together. The influence of heredity is prominent in the association of diabetes with obesity. For many years the inheritance may show itself only as a vice of metabolism, with abnormal fat-production, but the diabetes develops later on. In many cases we find diabetes related both to gout and obesity. In the analysis of 600 cases of diabetes, above referred to by Schmitz, there were 35 of diabetogenous obesity, and it is thought that many of these cases were of the gouty variety.

Lesions of the Pancreas.—To Lancereaux belongs the credit of having first directed attention to the association and, as he believes, the causative relation between certain cases of diabetes mellitus and lesions of the pancreas. He separates these cases into a distinct group, characterized by sudden onset, grave symptoms, marked emaciation, and rapid progression. Since Lancereaux's communication (1877) the number of cases of diabetes mellitus which have been found post-mortem to be associated with lesions of the pancreas has been constantly increasing. Accordingly, a *pancreatic type* of the disease has become recognized.

The lesions of the pancreas with which diabetes mellitus has been associated are—fibrosis, atrophy from pressure or other causes, acute inflammation, abscess, necrosis, calculi, occlusion of the duct, cysts, fatty degeneration, and carcinoma.

Hansemann[1] states that the most common lesion is a form of atrophy which he designates granular atrophy, and compares to certain forms of granular kidney. It is essentially the same lesion as that described by Lépine and Barral as periacinal fibrosis. The pancreas is rarely entirely destroyed by this form of atrophy. Hoppe-Seyler believes that in many cases of fibrosis of the pancreas the primary lesion is an endarteritis which encroaches upon the lumina of the affected vessels and diminishes the nutrition to the parts supplied by them. Syphilitic changes in the arteries of the pancreas may be the starting point of a fibrosis.

From a study of cases in the Berlin Pathological Institute and Augusta Hospital, Hansemann has found that the association of diabetes mellitus with lesion of the pancreas occurred more frequently than diabetes alone or disease of the pancreas alone, and, in fact, more frequently than both combined. He concludes from this study that there is no positive objection to the application of the results of experimental diabetes in animals to man; that complete destruction of the pancreas in man may be assumed to cause diabetes mellitus; that destruction of the pancreas does not produce any special form of diabetes; and that pancreatic diabetes has no relation to the age or sex of the individual. Though the evidence in favor of a causative relation between lesions of the pancreas and diabetes mellitus is increasing, this relation is not as yet understood, nor can it be stated as an indisputable fact. Cases of diabetes occur without lesion of the pancreas, and, on the other hand, extensive lesions of the pancreas have been observed without diabetes. The theory in explanation of the relation of diabetes to lesions of the pancreas will be considered under the Pathogenesis (p. 838).

Other Diseases.—Among the acute diseases which diabetes mellitus has been reported as following may be mentioned malaria, influenza, and measles. In many of the cases the patient is said to have been in perfect health prior to the onset of the acute disease. It may reasonably be questioned, however, if these diseases stand in a direct causal relation to diabetes mellitus. Some other factor or factors of recognized potency may have been overlooked. When diabetes follows a febrile disease it usually appears during convalescence.

Emil Schnée insists upon inherited syphilis as an etiological factor in diabetes mellitus. Tchistiakoff believes that syphilis in its early incubation stages may produce a diabetes of benign nature by causing perverted metabolism. These cases yield readily to antisyphilitic treatment, and sometimes subside spontaneously upon the appearance of the eruption.

According to Charnaux,[2] syphilis is more commonly a cause of diabetes than is generally thought. It occurs with the tertiary manifestations, and may depend upon syphilitic lesions in the nervous system or in the pancreas. In other cases the syphilitic infection determines the onset of diabetes in persons predisposed to the latter from other causes.

Unclassified Causes.—Diabetes mellitus may begin during pregnancy or occur only at this period. It has followed severe hemorrhages, severe bodily exertion, sexual excesses, single errors in diet, and exposure to

[1] *Zeitschr. für klin. Med.*, Berlin, Bd. 26, and *Am. Journ. Med. Sci.*, March, 1895.
[2] *Thèse de Paris*, 1894.

cold and wet. The disease has occurred also in connection with extensive eczema and other skin eruptions. Though the association of diabetes with the circumstances and diseases above mentioned has been well authenticated, a causal relation has not been established.

PATHOGENESIS.—The pathogenesis of diabetes mellitus is unknown. Various theories have been advanced to explain the nature and causation of the disease, and each theory has had ardent supporters. The lack of uniformity in opinion lies in the fact that all cases with sugar in the urine and more or less marked constitutional symptoms are probably not of the same nature, and probably do not rest upon the same ultimate basis. While all glycosurias are in a sense symptomatic, it can only be said positively of them at the present time that they are symptomatic of an excess of sugar in the blood, and not necessarily of the factors which underlie this excess.

The principal theories of the cause of diabetes mellitus relate to a perverted glycogenic function in the liver, to perverted metabolism in the tissues generally, to alterations in the pancreas, and to trophic disturbances.

Liver Theories.—There are two theories concerning the rôle which the liver plays in the causation of diabetes mellitus. One theory supposes a depressed glycogenic function in the liver—that the liver cells are unable to convert the digestive sugars (dextrose or dextrose and lævulose) brought to them in the portal blood into glycogen, and that, in consequence, sugar accumulates in the blood (hyperglycæmia) in greater quantity than can be made use of by the tissues to be thrown off through the kidneys as waste.

The other theory supposes an inability on the part of the liver cells to properly retain glycogen after it has been formed, or, in other words, that the hepatic glycogen is transformed too rapidly into sugar, and that the sugar accumulates in the blood. It is conceivable that this too rapid transformation of glycogen into sugar may be brought about in either of two ways: through some local cause in the liver—*e. g.* through the increased activity of some ferment—or through disturbance of the trophic nerves to the liver. This latter factor will be considered in another paragraph.

Pavy advocates the former theory—that is, that the sugar reaching the liver in the portal vein is not converted at all, or but partially, into glycogen, the unaltered sugar passing directly into the general circulation.

In cases of gouty glycosuria Duckworth and Ord hold that the fault of the liver lies in the too rapid conversion of glycogen into sugar under the action of the gouty influence.

Other Glycogen-holding Tissues.—This theory supposes an inability on the part of the muscles, glands, and other glycogen reservoirs to appropriate the sugar which is brought to them in the blood, and this even though the glycogenic function of the liver be properly performed.

Lépine would explain this perverted metabolism in the tissues by reason of the absence of the glycolytic or sugar-splitting ferment from the blood.

Pancreas Theory.—The relation between lesions of the pancreas and diabetes mellitus was placed upon a scientific basis in 1889 by the

experiments of Von Mering and Minkowski. They found that total extirpation of the pancreas was followed in all cases in the course of a few hours by the appearance of sugar in the urine. The amount of sugar which appears is considerable—from 5 to 10 per cent. even in fasting animals. This experimental diabetes is accompanied by polyuria, polyphagia, polydipsia, and marked emaciation, and proves fatal within fifteen days or less. These results are obtained only when the entire gland or more than nine tenths of it have been removed. If one tenth of the gland is left, a mild glycosuria follows the ingestion of carbohydrates, but does not occur otherwise. It is not necessary that the remaining portion of the gland be in its normal situation. Successful grafts under the skin of the abdomen or elsewhere will prevent the occurrence of the glycosuria and other symptoms. If, however, the graft be subsequently removed, the glycosuria and other symptoms appear, and the experimental disease progresses to a rapidly fatal issue.

The symptoms produced by total extirpation of the pancreas do not depend upon the loss of the pancreatic juice proper to the organism, as has been shown by Schiff, Hédon, and Thiroloix. This secretion may be diverted from the intestine through a pancreatic fistula without the production of diabetes. Moreover, Hédon and Thiroloix, among others, have rendered the acini of the gland functionally inactive, and ultimately destroyed them, by the injection of paraffin or other substances into the duct of Wirsung, without the supervention of diabetes. These experiments have led to the conviction that the little groups of epithelial-like cells situated in the connective-tissue stroma of the pancreas secrete something which is absorbed into the circulation (Schäfer) and constitutes its *internal secretion*. Lépine ascribes a glycolytic or sugar-splitting property to this supposititious secretion, and has sought to prove the existence of such a ferment normally in the blood, the removal of which from the blood deprives the tissues of the power to convert glucose into glycogen or to store it up as fat, and permits the destruction of albumin. Arthus admits the presence of the glycolytic ferment in blood drawn from the body, but contends that it is the product of post-mortem changes. Minkowski also states that Lépine's experiments are not sufficient for the proof of his theory. Though a satisfactory explanation cannot be given at the present time of the genesis of pancreatic diabetes, the fact remains that in the dog and certain other animals total extirpation of the pancreas results in the production of grave diabetes.

Following the lead of Lancereaux, whose deductions were made from bedside and post-mortem observations, the results of these experiments in animals have been applied to man, and pathological changes in the pancreas have come to be considered a cause of diabetes mellitus. The lesions of the pancreas which have been found in cases dead of the disease have been enumerated. Certain observers would make the theory more comprehensive still, and include cases in which there is no demonstrable lesion of the pancreas, assuming a depressed functional activity.

Trophic Disturbances.—Physiologists believe that many if not all metabolic processes, both assimilative and disassimilative, are dependent in the main upon nerve action. The trend of experiments has been to confirm this belief. It would lead too far to cite experimental proof.

In diabetes mellitus it is conceivable that either the sugar-assimilative or sugar-disassimilative process, or both, are perverted: that the sugar which is brought to the tissues, including the liver, is not properly transformed into glycogen or otherwise consumed; or that there is too rapid conversion of glycogen into sugar—in either or both cases with a resulting hyperglycæmia.

The famous experiment of Claude Bernard of producing glycosuria by puncturing the floor of the fourth ventricle has been referred to. The glycosuria so produced is of short duration, disappearing altogether in a few hours, or in a few days at most. It has been found in performing this experiment that the amount of sugar excreted, and, in a measure, the length of time the glycosuria continues, is dependent upon the condition of the liver regarding its store of glycogen. If the liver is rich in glycogen, the glycosuria is marked; while, on the contrary, if the animal has been deprived of food for some days prior to the operation, so that the liver contains but little glycogen, the glycosuria is less marked or may even not occur. The presence of glycosuria after puncture of the floor of the fourth ventricle is explained by supposing that the store of glycogen in the liver is suddenly discharged after the operation as the result of nerve impulses. Recent experiments[1] have shown that these impulses do not proceed from the vaso-motor centre. In addition to this experiment of Bernard's, it has been found that glycosuria may be produced by ablation of the lower cervical and upper dorsal sympathetic ganglia, by section of the cord, by stimulation of the peripheral end of the divided pneumogastric, and that the amount of sugar in the liver may be increased by stimulation or removal of the cœliac plexus.

In addition to this experimental evidence of the influence of the nervous system upon the katabolism of glycogen, we have the fact of the occurrence of glycosuria as a result at times of the various nerve lesions already mentioned.

It is inconceivable that so many different lesions of the nervous system in so many different parts of it could produce glycosuria in as many different ways. There must be some kind of uniformity in action among them. Moreover, diabetes mellitus has been known to occur in connection with neuroses—*e. g.* exophthalmic goitre.

It seems not improbable, then, that some types, or some cases at least, of diabetes may be caused by trophic nerve disturbances.

Disturbances of the trophic nerves may affect the liver alone, or the glycogen-holding tissues generally, such as the muscles and glands, so that the glycogen in either situation is converted more readily than normal into sugar, or that something which is not glycogen (albumin—Pavy) is converted into sugar, or both.

A chief difficulty in explaining the pathogenesis of diabetes mellitus rests upon the fact that it is not probable that all cases depend upon a single cause. Some perhaps are to be explained through perverted metabolism in the liver; others through perverted metabolism in the tissues; others, again, through both these causes; while still others may be referable to the absence of the glycolytic ferment from the blood. However the result may be effected, in all cases of glycosuria and dia-

[1] Cavazzani: *Centralblatt für Physiologie*, Vienna, v. 8, 1894.

betes mellitus sugar appears in the urine because it is present to excess in the blood.

Contagion Theory.—A discussion of the pathogenesis of diabetes mellitus would not be complete without mention of the contagion theory suggested by R. Schmitz. In 26 of 2320 cases the disease appeared to be acquired through transmission from a diabetic subject, and this where no other cause, such as heredity, gout, occupation, etc., could be assigned. The majority of these cases occurred in husband or wife, especially the latter, after years of intimate contact.

Pathological Anatomy.—Few anatomical changes belong, properly speaking, to diabetes mellitus. Lesions have been found in different cases in the cerebro-spinal axis, in the peripheral nerves, and in the pancreas. These lesions have been described at sufficient length under Etiology (pp. 833, 836). They cannot be considered constant. In fact, cases occur in which practically no lesion is discernible, either microscopically or macroscopically.

Such lesions as may be found in the lungs, skin, kidneys, etc. are referable to the complications of diabetes rather than to the disease itself.

The liver presents no constant changes, though passive congestion is perhaps most frequently met with.

The kidneys are often hypertrophied, probably from the excessive amount of work thrown upon them. Ehrlich discovered a glycogen infiltration of Henle's loop which is constantly present in diabetes. The presence of the glycogen may be demonstrated by the iodine reaction. The cells of the loop are swollen and have a hyaline appearance.

The blood in diabetes often contains such an amount of fat (lipæmia) that the serum looks milky. Sometimes the fat globules escape through the kidneys, causing lipuria.

General Symptoms.—In a typical case the first symptoms of diabetes mellitus are *thirst* and increased *frequency of micturition*. As a rule, the onset is insidious, the patient being unable to fix definitely upon the time that these symptoms appeared. From time to time he has noticed that he was passing urine more frequently and in greater quantity than had been his habit, or that he was awakened from sleep to find his bladder full, or, what is a little more unusual, excessive thirst may first attract his attention. In any event, both symptoms soon become pronounced and the patient consults his physician.

Less frequently the disease begins with gastro-intestinal disturbances, such as anorexia, eructations, nausea, vomiting, or irregularity of the bowels, to be followed later by the classical symptoms, polyuria and polydipsia. And sometimes the onset is characterized by nervous phenomena, headache, insomnia, paræsthesiæ, and diminution of sexual desire (Seegen); or the first symptoms to appear may be gradually increasing languor, with disinclination to, and inability for, exertion, and a gradual loss of flesh. Undoubtedly, however, the most frequent early manifestations are unusual and excessive thirst and an increase in the quantity of urine.

In marked contrast to cases where the development of the disease is so insidious that the patient does not know when the morbid phenomena first appeared are those in which symptoms of marked severity date

from a definite time. These are generally the cases which follow immediately upon a violent emotion, an injury, or are associated with lesion of the pancreas, and they frequently progress to a rapidly fatal issue.

For a long time excessive thirst and increased frequency of micturition may be the only symptoms. This is especially likely to be the case in the milder forms of the disease. They may, however, become the source of great annoyance to the patient during the day, and at night may interfere with his sleep to such an extent that his general health becomes impaired. He is awakened again and again by the demand for water or the desire to empty his bladder. The mouth remains parched and dry, despite the large quantities of water drunk, because of the excessive loss of water through the kidneys. The amount of urine excreted bears a direct relation to the amount of liquid ingested, and is always, except for brief periods, a little less. The thirst and total daily excretion of urine vary with improvement or aggravation in the condition of the patient.

The *appetite* increases sooner or later, sometimes to a ravenous extent—polyphagia or bulimia. Eating, however, relieves the intense longing for food for but a short time. In spite of the enormous amounts of food consumed, the patient not only does not gain in weight, but may actually lose flesh. This is due to failure of assimilation, not imperfect digestion. The extent to which emaciation proceeds and the rapidity with which flesh is lost vary in different cases, and in general correspond to the severity of the type of the disease. When, instead of losing flesh, patients gain in weight and become obese, the cases belong to the type called lipogenous diabetes or diabetogenous obesity. Not in every case of diabetes is flesh either lost or gained. In many cases the weight remains stationary. Debility and incapacity for physical exertion accompany emaciation, and may become extreme. The patient is wholly unable to make any sustained effort—in fact, becomes exhausted from the least exertion.

The skin is harsh and dry and feels cool. There may be entire absence of perspiration. In all cases where the quantity of urine excreted is large the perspiration is at least diminished. Exceptions are sometimes found in cases complicated by pulmonary tuberculosis, where drenching sweats may occur. In many cases there is intolerable itching of the skin. Other cutaneous phenomena will be considered under Special Symptoms.

The temperature is often a degree or more below normal. The heart-action may be normal or weak. The pulse is variable, being sometimes as low as 50 to 40 beats per minute, sometimes as high as 120. The breath has a heavy, sweetish odor which has been compared to hay, chloroform, and apples by different observers. Many special symptoms occur in diabetes. They will be grouped under separate headings.

Special Symptoms.—The Urine.—*Sugar.*—The most important constituent of diabetic urine is sugar. It is present in the form of glucose or grape sugar (dextrose). The quantity of sugar present in the urine may vary in different cases from a few grammes to 500 grammes, or even more, in twenty-four hours. It may vary, moreover, in the

same case at different times under the influence of diet or improvement or aggravation in the patient's condition. The largest quantity of sugar which has ever been observed in twenty-four hours was 1500 grammes (Dickinson). In cases of ordinary severity the amount does not exceed 100 to 200 grammes. In percentage composition the quantity of sugar varies from 0.5–1 per cent. as a minimum to 8–10 per cent. as a maximum, with an average of 2–4 per cent.

It is thus seen that the quantity of sugar lost to the body is subject to great variation, not only in different cases, but in the same case at different times. This variation is dependent upon a variety of factors, the most important being the severity of the type of the disease. The severer the disease the greater the quantity of sugar excreted, and the milder the disease the less the quantity, other things being equal. In either case the quantity of sugar is much influenced by the quality and quantity of food eaten. In mild cases the quantity of sugar is largely dependent upon indiscreet indulgence in carbohydrate and saccharine foods. Approximately definite (small) amounts may be taken by these individuals without the production of glycosuria, whereas if these amounts be exceeded sugar appears in the urine. In severe cases sugar continues to be excreted even upon a purely proteid diet through the formation of sugar from the albumin molecule, while the addition of carbohydrates to the diet, even in small quantity, causes an immediate increase in the quantity of sugar excreted. Improvement or aggravation in the condition of the patient is measured by diminution or increase in the amount of sugar which is lost. Any factor or factors which tend to render the patient's condition more serious will increase the quantity of sugar. Such factors are nervous strain, nervous excitement or exhaustion, or any of the factors which we saw, under Etiology, are actively productive of the disease.

The amount of sugar diminishes under the taking of exercise (Von Mering), since a portion of the sugar which otherwise would escape through the kidneys is consumed in the muscle metabolism. This statement does not hold good for all cases, however (Külz). The sugar is also diminished upon the incidence of many acute diseases, such as typhoid fever, as a result of gastro-intestinal disturbances, and in gouty cases when active articular or other symptoms supervene. In fact, in gouty individuals the sugar disappears entirely from the urine when gouty symptoms present themselves. Frerichs states that sugar may disappear in diabetes when chronic interstitial nephritis has developed. And, finally, sugar diminishes or disappears in the later stages of diabetes when death is imminent.

Other varieties of sugar than dextrose may be present in the urine—*e. g.* dextrine, lævulose, lactose, etc.

Quantity.—The quantity of urine excreted bears a direct relation to the amount of liquid ingested, and is usually a little less than this amount. In cases of moderate severity the quantity of urine varies from 2000 to 3000 c.c. (70–100 ounces). Extreme amounts, such as 8000 to 12,000 c.c. (8–12 quarts) may be reached in the twenty-four hours.

Less urine is secreted during the night, as a rule, than during the day—a symptom of diagnostic value, since in other diseases or condi-

tions causing an increase in the quantity of urine the reverse is usually the case. Not infrequently the quantity of urine becomes increased before sugar makes its appearance, and, on the other hand, an increased quantity of urine may continue to be excreted after the sugar has disappeared. This latter fact is to be explained in most cases by the patient's continuing to take large quantities of water merely from habit. In nearly all cases an increase in the quantity of sugar brings about an increase in the quantity of urine, and, on the contrary, a diminution in the amount of sugar is followed by a lessened quantity of urine. This does not hold true for all cases, however. A diminution in the quantity of urine occurs upon the intercurrence of acute diseases and when death is imminent from the diabetes itself.

Cases are sometimes met with in which the quantity of urine is not increased, though it contains sugar. These cases have been called *diabetes decipiens*. Ultimately they assume the characters of ordinary cases.

Specific Gravity.—The specific gravity of diabetic urine varies from 1020 to 1045, and may even reach 1070. All pale urines with a specific gravity of more than 1025 should be regarded with suspicion. It is important to remember, however, that sugar may be present in urine with a specific gravity of less than 1020. The specific gravity of diabetic urine varies in direct ratio with the amount of sugar present, and we have already seen that, with the exception of diabetes decipiens, an increase in the amount of urine always signifies an increase in the amount of sugar. This increase in specific gravity, corresponding to an increase in the amount of urine, forms an exception to the general rule in disease.

Color.—The color of diabetic urine is generally pale. It may be as light in color as water and possess a greenish hue, or it may be light yellow. The urine is perfectly clear when voided, but soon becomes clouded on standing from the development of yeast cells (torulæ cerevisiæ).

Odor.—The urine possesses an aromatic odor which has been variously compared to the odors of hay, chloroform, or apples (fruity).

Reaction.—Diabetic urine is acid in reaction, the degree of acidity increasing during fermentation.

Urea.—The daily output of urea is increased. Usually the quantity is in accord with the amount of nitrogenous food ingested. Exceptions occur in cases where emaciation is taking place: here the individual is consuming the body proteids, and the excess of urea excreted over the amount of nitrogen received corresponds to the extent of this consumption.

Uric Acid.—The quantity of uric acid excreted daily is unaffected or but slightly increased (Taylor; Staatz; Von Noorden). In gouty cases, however, Haig states that the quantity is increased, the glycosuria corresponding to an excess of uric acid in the blood (uricacidæmia). It has been a matter of frequent observation in these cases that the glycosuria terminates with a copious deposit of urates, and for a long time this has been regarded as a favorable sign.

Kreatinin is excreted in increased quantities, as much at times as 1.5 to 2 grammes per diem. It results from the large amounts of meat con-

sumed, and, to a certain extent, from destruction of the body proteids when emaciation forms a pronounced feature of the disease.

The *mineral constituents of the urine* are increased in amount, and in general vary in accord with the polyphagia. Sometimes the excretion of phosphates is increased beyond the amount which can be explained through the ingestion of proteids, and they may either replace or correspond with the amount of sugar in the urine (Teissier). And in the case of *ammonia* the daily excretion is often beyond the normal (0.5 to 1.5 grammes). The amount for twenty-four hours not infrequently reaches 3 to 6 grammes. Von Noorden states that the larger amounts "belong almost exclusively to the stage of diabetic coma," while the smaller may be excreted in ordinary cases for periods of weeks or months. This increased excretion of ammonia is believed to depend upon an increased acidity of the blood (Minkowski; Stadelmann) from the presence of β-oxybutyric, aceto-acetic, and other acids. The amount of ammonia excreted frequently runs parallel with the amounts of acetone and aceto-acetic acid. The reaction of the urine is not made alkaline by these large amounts of ammonia because of the presence of β-oxybutyric acid.

Acetone is present in traces in normal urine and in a variety of pathological states, the commonest being the febrile (Von Jaksch). Hirschfeld has found that the excretion of acetone by the healthy subject and in pathological conditions generally is governed to a large extent by the nature of the food—that an exclusively albuminous diet favors its excretion, while the addition of carbohydrates causes a diminution in the amount of acetone or its actual disappearance from the urine. Though this is true for the milder cases of diabetes, in severe forms the inhibitory action of the carbohydrates upon the excretion of acetone is lost from the failure of the tissues to make use of them. It is generally agreed that an increase in the amount of acetone excreted is dependent upon an increased destruction of albumin in the body, though opinions differ as to whether the albumin is that of the body or that of the food. Von Noorden believes that acetone is never formed from the albumin of the food, and that a large amount of acetone in the urine always indicates destruction of the body albumin. Beyond the fact that acetone is derived from albumin, little is known of its origin. Von Jaksch and Deichmüller believe that acetone is formed from aceto-acetic acid. Other observers think it is derived from β-oxybutyric acid, since this acid upon oxidation yields aceto-acetic acid and a substance which is readily decomposed into acetone and carbon dioxide. The amount of acetone excreted in twenty-four hours may vary from a few decigrammes to several grammes.

Aceto-acetic Acid.—While acetone is found in normal urine, the presence of aceto-acetic acid (diaceturia) is always indicative of a pathological condition. In diabetes its presence indicates a severe form of the disease, and, according to Von Jaksch, the advent of coma. Urine containing aceto-acetic acid always contains a large amount of acetone.

β-oxybutyric acid, as already stated, is believed by many investigators to be the source of aceto-acetic acid and of acetone. Von Noorden, however, insists that β-oxybutyric acid and aceto-acetic acid arise through essentially distinct katabolic processes. The amount of β-oxy-

butyric acid excreted in twenty-four hours varies from a few grammes to 50, 100, or 150 grammes. After it has once appeared in the urine the amount excreted progressively increases as a rule, and without interruption except for brief periods. The presence in the urine is regarded as a symptom of grave significance. Stadelmann states that diabetic coma occurs only in the case of patients whose urine contains this acid, and, according to Von Noorden, its appearance is followed by coma within a few days or weeks at most. Large amounts of β-oxybutyric acid in the urine generally correspond with large amounts of ammonia. The relation of this acid to diabetic coma will be considered in connection with the symptoms of the coma (p. 849).

Albuminuria is of frequent occurrence in diabetes mellitus. Statistical tables give percentages varying from 5–10 to as much as 50–66 per cent., according to different observers. These discrepancies are explained by the fact that some authors include only cases in which there is distinct evidence of nephritis, while others include every case in which a trace of albumin appears in the urine.

The frequency of albuminuria, aside from nephritis, in diabetes varies according to the age and sex of the patient and the form of the disease (Jacobson[1]). Thus it is rare in infants, common in adults between the ages of forty-five and fifty-five, and most frequent in old men. For the sexes, Lecorché and Talamon give 50 per cent. of their cases in males and only 11 per cent. in females.

The subject of nephritis will be considered under Complications (p. 851).

Alimentary Tract.—The *tongue* is enlarged and is red and glazed or coated. Its surface may be fissured. The papillæ are often swollen. The sense of taste may be blunted. The saliva generally does not, but may, contain sugar, in which case there is a sweet taste in the mouth. The reaction of the saliva may be alkaline, neutral, or acid.

Sometimes the *gums* are soft and swollen and bleed easily. On the other hand, they may shrink and leave the roots of the teeth exposed. Caries of the teeth occurs in a certain proportion of cases, or without carious changes they may fall out from an alveolar periosteitis. Affections of the teeth are not confined to any period of the disease; they may occur either in the early or late stages. Aphthous patches in the mouth are common.

The *digestion* is usually good, even though such large amounts of food are eaten. A peculiar feature of the disease is that the enormous quantities of food consumed relieve the hunger but for a short time. There are no constant changes in the quantity or quality of the gastric juice. The bowels are usually regular or constipated, though there may be a fatty diarrhœa from disease of the pancreas or interference with the flow of bile.

Skin.—The commonest special symptom referable to the skin is general or local itching. In fact, itching of the skin may be the first symptom to attract the patient's attention. When local the itching affects chiefly the external genitalia or their neighborhood. Local itching is more common in women than in men, and of women in those

[1] *Gaz. des Hôpitaux*, Paris, Aug. 25, 1894, and *Medical Chronicle*, Manchester, October, 1894.

who are not cleanly in their habits. The labia may itch intolerably, and the scratching may lead to a dermatitis which often extends to the groin and adjacent portions of the thighs. Itching about the genitals is supposed to be due to the growth of a fungus on and in the skin moistened by the sugary urine.

Men not infrequently suffer from itching of the penis, and more particularly of the glans and prepuce. Balanitis and phimosis may occur. The itching sometimes is located at the meatus or on the scrotum.

Nervous symptoms are common in diabetes mellitus. They present themselves under a variety of forms. Since it is difficult to differentiate the nervous symptoms belonging properly to the disease from those which may be regarded as complications, all the nervous phenomena will be considered together. As we have seen, it is believed that certain lesions and other disturbances of the nervous system stand in a causal relation to certain cases of diabetes mellitus. We shall now see reason to believe that certain nervous phenomena, and even nerve lesions, are dependent directly or indirectly upon diabetes mellitus.

The commonest and most characteristic nervous phenomena of diabetes are disturbances of sensation dependent upon a peripheral neuritis, which may be multiple or affect single nerves. These disturbances take the form of neuralgias, pains in the calves of the legs, hyperæsthesiæ, partial or complete local anæsthesiæ, paræsthesiæ, and herpes. The neuralgias of diabetes are especially prone to affect the third branch of the fifth cranial and the crural nerves. They are obstinate and rebellious to treatment. Pains in the calves of the legs are not infrequently among the earliest symptoms of diabetes (Unschuld), and have a diagnostic significance. Auerbach has described a hyperæsthesia of the soles of the feet which seriously interfered with walking.

Motor disturbances as the result of neuritis are not so common as disturbances of sensation. Ataxia, or actual paralysis with atrophy and the reaction of degeneration, may occur, however. The lower extremities are affected more frequently than the upper. Paralysis of the ocular muscles may occur.

Patellar Reflex.—Bouchard first described the absence of the patellar reflex as a symptom in diabetes mellitus. This symptom is present in a varying proportion of cases; thus both Grube and Grübl found it in only 7.6 per cent., while Williamson found it in 50 per cent. The absence of the patellar reflex has no relation to the severity of the disease nor any diagnostic or prognostic significance (Grübl). In some cases the patellar reflex is normal, in others exaggerated. The absence of the reflex, taken in connection with ataxic symptoms, has led at times to the diagnosis of this condition as tabes or pseudo-tabes.

Mental Symptoms.—Patients suffering from diabetes mellitus are often irritable and are inclined to be sad or moody. They may be dull, and in all severe cases there is a disinclination for mental exertion. Impairment of memory and insomnia (due to nervous causes rather than the state of the genito-urinary apparatus) are not infrequently observed, and, on the other hand, periodic attacks of somnolence may occur. Diabetics sometimes suffer from neurasthenia or hysteria. The decrease of the sexual desire has been referred to. It is generally a late manifestation, though it may appear early. The patient may become

hypochondriacal. The insanity of diabetes usually takes the form of melancholia (Auerbach), and the melancholia may present suicidal or homicidal tendencies. Legrand du Saulle has reported several cases in which the patients believed they were financially ruined, and he thinks this delusion very characteristic of diabetic insanity. Occasionally the sugar has disappeared from the urine upon the incidence of the mental symptoms, and has remained permanently absent. In other cases there has been alternation of symptoms of diabetes mellitus with symptoms of melancholia, and in still others there has been correlation of the mental and diabetic symptoms.

Von Noorden classes such symptoms as thinning and falling out of the nails, falling out of the teeth without disease of the jaws, and spontaneous grangrene without pre-existent arterial sclerosis, as *trophic* disturbances.

Diabetic Coma.—The most important nervous phenomenon of diabetes is diabetic coma. This complex of symptoms as a terminal feature of diabetes has been known since the time of Prout and even before, but was first systematically studied by Küssmaul in 1874. Diabetic coma occurs generally in well-pronounced types of the disease, and most frequently between the ages of twenty and forty. Cases may occur earlier or later in life, however. Moreover, coma may occur in mild cases, and even where the existence of the disease has been hitherto unsuspected. Not every case of coma occurring in the course of diabetes is diabetic coma. Coma may and does occur in diabetes from rupture of a cerebral vessel. Moreover, coma may result as a manifestation of uræmic intoxication if nephritis is a complication. And, again, Frerichs and others insist upon the occurrence of a cardiac diabetic coma—a coma the result of cardiac weakness and not of auto-intoxication.

Diabetic coma may occur without warning or its advent may be heralded by premonitory signs which extend over a period of a few hours to a few days. In some cases the coma has been preceded by nausea and vomiting. More commonly, however, it begins with headache, restlessness, excitement, anxiety, and thoracic or epigastric oppression. After a varying time these symptoms abate: the patient becomes drowsy, somnolent, and passes, sometimes rapidly, sometimes slowly, into a deep coma, disturbed, if at all, only by twitchings of muscles. The pupils are dilated. The pulse becomes small and frequent. The respirations are usually increased in frequency and assume a peculiar type—long-drawn inspirations, short expirations. The patient's breath is heavy with the odor of acetone (resembling hay, chloroform, apples): the odor frequently pervades the whole room. There may be great dyspnœa—a condition which Küssmaul has termed *air-hunger*. Cyanosis develops, and usually deepens. The extremities become cool; the body temperature as a whole falls, sometimes as low as 86° F. (30° C.); and the patient dies, generally without a return to consciousness, after a period of twenty-four to forty-eight hours, rarely longer.

Fatigue, mental or physical, nervous excitement, shock as from physical pain, venereal and alcoholic excesses, and sudden change to a diabetic diet have been accounted exciting causes of diabetic coma, having often been observed to precede it. In other cases the outbreak has followed gastro-intestinal disturbances, such as nausea and vomiting

or diarrhœa. Again, the exciting cause has seemed to be some phlegmonous process or a simple pharyngitis. Hirschfeld[1] believes that insufficient nourishment is a potent factor in the production of coma, having observed its onset after emaciation from insufficient alimentation, and sometimes after the institution of an improper meat diet. While febrile diseases generally do not seem to determine the development of coma, several cases have followed closely upon an attack of influenza.

Diabetic coma is the result of an auto-intoxication. The toxic substance is not definitely known. It is known, however, that diabetic coma usually occurs only in cases the urine of which contains β-oxybutyric acid (Stadelmann[2]), and, on the contrary, that when this acid makes its appearance in the urine in more than the merest trace diabetic coma generally follows in a few days or few weeks (Von Noorden). Hence the acid-intoxication theory, that diabetic coma is due to the presence in the blood of β-oxybutyric acid alone or in combination with other fatty acids. This theory has met with many adherents, notably Stadelmann and Minkowski.

Klemperer,[3] however, thinks the theory is not justified by the facts, and for two reasons: that the administration of alkalies is without effect on the coma, and that coma may occur in other diseases when there is excessive destruction of albumin—*e. g.* pernicious anæmia. It has been objected that the treatment with alkalies has been begun too late, after irreparable injury had been done to the nervous system. In one of Klemperer's cases, however, this objection seems to have been met. This patient was excreting large amounts of ammonia, indicating the formation of organic acids in his system. He was put upon large doses of sodium bicarbonate daily for several weeks before his death. The amount of ammonia diminished, and the urine was often even alkaline in reaction, yet the patient died in diabetic coma. Klemperer concludes that we are not justified in assuming more as to the cause of diabetic coma than that there is some toxic substance in the blood which increases its acidity and produces the coma as co-ordinate phenomena—that the coma occurs with, but not by reason of, the acid in the blood. Several cases of diabetic coma have been published in which β-oxybutyric acid was absent from the urine (Rumpf; Roger; Devic; Hugounenq).

Von Jaksch[4] believes that diaceturia in diabetes (aceto-acetic acid) "commonly forebodes the advent of coma." This view is opposed by Von Noorden and others.

The theory that diabetic coma is due to acetonæmia has been abandoned.

Schmitz[5] recognizes two varieties of diabetic coma: (1) A form dependent upon cardiac weakness, and (2) a form resulting from auto-intoxication. According to Frerichs, the first class of cases are not to be regarded as genuine diabetic coma. Schmitz believes that the toxic agent which is the cause of the coma in the second form is generated in

[1] *Deutsche medicinische Wochenschrift*, Leipzig, June 27, 1895.
[2] *Ibid.*, 1889, No. 46.
[3] *Münchener medicinische Wochenschrift*, Munich, May 14, 1895.
[4] *Clinical Diagnosis*, English trans., 1893.
[5] *Berliner klinische Wochenschrift*, Berlin, Aug. 25, 1890.

the intestines, and states that the coma is preceded by symptoms which may easily be mistaken for those of gastric catarrh. These symptoms are a suddenly developed anorexia, gaseous eructations, foul breath, heaviness with an inclination to sleep, constipation, and sometimes diarrhœa. Colicky pains are likely to occur. After these symptoms have continued for several days the patient passes into a prolonged sleep with accelerated pulse and respiration.

Complications.—*Skin.*—*Furunculosis* occurs in a large proportion of the cases of diabetes (from one tenth to one fourth of them—Von Noorden), and in all instances is due to the presence of micro-organisms, generally the staphylococcus pyogenes aureus. Furuncles may occur in any form of the disease and at any time during its course. Their number is not infrequently increased through infection of the fingers in scratching and transmission of the organisms to other parts of the body. It is important to remember that furunculosis is sometimes among the early symptoms of the disease. Carbuncles and phlegmonous inflammations may also occur, but are not so common as furuncles.

Other affections of the skin are eczema, either about the genitals or on other parts of the body, and xanthoma diabeticorum.

Wounds of the skin do not heal kindly in diabetics, and exhibit a tendency to sloughing and gangrene.

Œdema occurring independently of nephritis and vaso-motor disturbances is to be referred to the heart.

Eye.—Cataract is the most common of the eye complications of diabetes mellitus. It is usually double and of rapid development. It occurs most frequently in young adults suffering from a severe form of the disease. Alterations in the vessels supplying the lens are believed to be the cause of the opacity.

Other affections of the eye which may be met with are retinitis, sometimes of the albuminuric form, optic neuritis, amblyopia, paralysis of the ocular muscles, iritis, opacities in the vitreous humor, and keratitis.

Tuberculosis.—There is no longer any question as to the identity of the tuberculosis complicating diabetes and that occurring as an independent disease. Pulmonary tuberculosis is the most frequent of the serious complications of diabetes. A large proportion of the cases of diabetes die from this cause. Pulmonary tuberculosis occurs especially in the later stages of diabetes, undoubtedly from lowering of vitality and greater susceptibility to attack. Patients in the early stages, however, are by no means exempt. The poor are affected oftener than those in comfortable circumstances, for sanitary reasons. Pulmonary tuberculosis is rare in diabetes of gouty and lipogenous origin.

The onset of pulmonary tuberculosis in diabetics is generally insidious, though it may be sudden. Its course is similar to the course of ordinary cases, except that hæmoptysis is rare. The development of this complication may, however, modify the course of the diabetes, causing a diminution in the quantity of urine and a diminution in, or disappearance of, the sugar. Sometimes the sugar is replaced by albumin.

Pulmonary gangrene is a rare complication, and generally follows lobar or broncho-pneumonia, though it may occur without a previous lesion of the lungs.

Lobar pneumonia is sometimes a complication of diabetes, and when it occurs is usually of a severe type.

Albuminuria and Nephritis.—Jacobson[1] states that two forms of albuminuria may occur in diabetes—the one benign, the other grave.

In the benign form the amount of albumin is small, its presence intermittent, and slight changes or none at all are found in the kidney at the autopsy table. Moreover, there are no symptoms of toxæmia, and the existence of albuminuria is discovered accidentally.

In the grave form, on the contrary, albumin is present in large amount, and constantly present. The urine may also contain granular and epithelial casts. There are symptoms of toxæmia, such as headache, visual disturbances, œdema, dyspnœa, and at the autopsy table well-marked evidences of nephritis are found. This form of albuminuria may be due to acute degeneration of the kidney cells (acute albuminuria of Maguire) or to chronic interstitial changes. The symptoms vary somewhat according to the condition of the urine. In acute cases the alterations in the kidney may lead to the retention of toxic products and the onset of uræmic or diabetic coma, as may be. In chronic cases the glycosuria, the polydipsia, and the polyphagia may diminish, then disappear, and the case become one of chronic interstitial nephritis.

Albuminuria is most frequently met with in diabetogenous obesity. It is also common in traumatic diabetes. It is rare in the so-called pancreatic diabetes. Chronic interstitial nephritis is to be regarded as a grave complication.

Ear.—A form of otitis media diabetica has been described, but Davidsohn[2] questions the etiological relation of the diabetes to the middle-ear disease, except to the extent of lowering the resisting power of the tissues. As in other cases, the otitis probably arises from the entrance of organisms through the Eustachian disease.

Arterial sclerosis sometimes complicates diabetes mellitus. It is especially prone to affect persons whose diabetes is of a gouty origin. It may occur, however, in cases where no history of gout is obtainable and in relatively young subjects. Sometimes arterial sclerosis is advanced when the diabetes is discovered, and it has been suggested that the arterial sclerosis may stand in a causal relation to the diabetes, especially when the arteries of the pancreas or the nervous system are affected.

Heart.—Israel found cardiac hypertrophy in 10 per cent. of his cases, and Saundby in 13 per cent. Mayer believes that the hypertrophy results from irritation caused by an excess of sugar and urea in the blood. Some of the cases are undoubtedly due to coexistent renal disease or arterial sclerosis.

Gangrene, when occurring as a complication of diabetes mellitus, affects by preference the lower extremities below the knee. Other parts which may become gangrenous are the thighs and buttocks, fingers, back, external genitals. The majority of cases have occurred after fifty years of age, though gangrene has been seen as early as the nineteenth year. The sexes are about equally affected. The gangrene may be moist or dry. There is rarely a clean-cut line of demarcation between the healthy and gangrenous tissues. The gangrene of diabetics may

[1] *Loc. cit.*

[2] *Berliner klinische Wochenschrift*, Berlin, Dec. 17, 1894.

follow injuries and operations or occur spontaneously. Pratsch has found endarteritis in gangrenous toes examined microscopically. The process is undoubtedly dependent upon vascular changes in many cases.

Pneumaturia is the term employed to designate the passing of gas from the bladder along with the urine. The condition has been studied by Senator,[1] Dumesnil, Thomas, and Fr. Müller. The gas is generated *de novo* in the bladder through fermentative processes, chiefly alcoholic, butyric, lactic, and possibly through the fermentation of albumin. The gases formed are carbon dioxide, methane, and sulphuretted hydrogen. The organisms which are generally present are the torula cerevisiæ, bacillus of butyric-acid fermentation, and bacillus coli communis. Other gas-producing organisms may, however, be found in the bladder.

Varieties, Course, Duration.—Two general types of diabetes occur—the mild type and the severe type. Many cases between these two extremes are met with, however, which it is difficult to assign to the one or the other class. Mild cases are by far the most frequent. Worms states that severe cases occur about five times in the thousand. The difference between mild and severe cases is chiefly one of degree. In the mild forms the symptoms which are present are not so pronounced, and many symptoms may be absent. It is important to recognize the mild forms early, because of the chance of staying the progress of the disease for years or ultimately arresting it.

Mild Type.—The onset in these cases is insidious. The symptoms do not date from a definite time. In fact, the disease may be discovered accidentally when the patient comes to the physician apparently for some other affection. Complications are by no means confined to the severe types of the disease. The symptoms of diabetes, if any are present, are not marked. There may even be no increase in the quantity of urine, no increased thirst, no change in the appetite, and yet the urine may contain sugar. The amount of sugar is generally small, though it is subject to fluctuation under the influence of diet and depressing factors.

Three varieties of the mild form deserve especial mention—the nervous, the gouty, and the obese.

The nervous variety presents vague nervous symptoms, often resembling neurasthenia—apathy, disinclination and incapacity for mental or bodily exertion, a sense of fulness in the head, neuralgic pains. In all such cases, and especially if there is a history of diabetes in the family, the urine should be examined for sugar.

The gouty variety generally occurs in robust, well-fed individuals in the middle period of life. They are often corpulent. As already stated, Duckworth does not consider these cases diabetes in the true sense of the term. The glycosuria is especially likely to alternate with uric-acid sediments or with more or less active articular symptoms. Slight increase of urine, slight dryness of the mouth, a little increase of thirst, some weakness, some loss of flesh, itching of the labia, and intercostal or other neuralgias are common symptoms, though all of them are not necessarily present in every case. Furunculosis is a frequent complication. Arterial sclerosis may develop and be the direct

[1] *International Beiträge zur Wissenschaftliche Medicin*, B. 3.

cause of contracted kidney or indirect cause of cerebral hemorrhage (Marechal). Cases of gouty glycosuria differ so widely from each other that each must form the subject of special study to the physician.

In corpulent persons there may be no symptoms to indicate the presence of sugar in the urine, and, if symptoms are present, they are mild. Yet cases do occur in which the disease takes on a severe form, with all the symptoms pronouncedly diabetic. Emaciation even may occur.

In the mild types of diabetes generally the amount of sugar in the urine is small, and it readily diminishes or disappears upon elimination of the carbohydrates and sugars from the food. Boils, carbuncles, visual disturbances, neuralgias, loss of sexual desire, and pulmonary tuberculosis are frequent complications. These complications may occur even though the amount of sugar remains small.

Patients may live in comparative comfort for years with a mild form of diabetes, now better, now worse, the condition varying under indiscretions in diet, fatigue, shock, nervous excitement, worry, etc. In fact, the diabetes may be brought to a standstill so far as the presence of sugar in the urine and other symptoms are concerned. The patients may even return to an ordinary diet without the reappearance of symptoms. But often the cure is only apparent, the diabetes recurring sooner or later from joy, grief, over-indulgence in eating, or without assignable cause.

If the mild cases are not recognized early and appropriately treated, they may pass into the severe form.

Gangrene and chronic interstitial nephritis may develop in cases complicated by arterial sclerosis.

Diabetes mellitus may undergo transformation into diabetes insipidus (Frerichs).

The mild forms of diabetes last for years—five, ten, or even twenty. Death is the usual result, the cause being some intercurrent disease or some complication, such as carbuncles, pulmonary tuberculosis, coma, or nephritis.

Severe Type.—Cases of the severe type of diabetes may be abrupt or gradual in their onset. Cases with sudden onset are generally those which follow some mental shock or bodily injury. From the very first the symptoms are of marked intensity. The patient suddenly begins to pass large quantities of urine and to suffer from an unquenchable thirst. He rapidly loses flesh, strength, and energy, and that in spite of large amounts of food consumed. The amount of sugar in the urine is large. The disease progresses steadily to a fatal termination in from one to two years. Death usually results from exhaustion, diabetic coma, or some complication, as pulmonary tuberculosis. In rare instances severe cases with sudden onset recover (Schmitz).

In other cases the onset is slow. The patient does not know when he first became sick. The increase in the quantity of urine, the thirst, the increase of appetite, all came on gradually, or he noticed that he was losing flesh for no apparent reason, or that he was no longer able to apply himself to business with his wonted assiduity. Sometimes the appearance of a complication may send him to his physician. Whatever may be the manner of onset, the symptoms soon assume a severe character. Because of the obscure nature of onset these cases often

remain unrecognized for a considerable time. The urine contains a large amount of sugar. Death usually results in from one to two years from exhaustion or some complication.

Cases of diabetes mellitus have been reported which have run their course in a few days or few weeks to a fatal termination. Such cases are called *diabetes acutus.*

Diagnosis.—The diagnosis of diabetes mellitus rests upon the constant presence of sugar in the urine, generally in considerable amount, accompanied, in the majority of cases, by more or less typical constitutional symptoms. It is not in well-developed cases with the classical symptoms, glycosuria, polyuria, polydipsia, and polyphagia, that doubt as to the diagnosis arises, but in those cases whose real nature is masked by symptoms of apparently some other disease or indefinite symptoms. The early recognition of diabetes is important, since the sooner the diabetic regimen is established and diabetic treatment instituted the greater is the hope of alleviating the symptoms and of effecting a cure if such is possible.

Attention has been directed under Symptoms (p. 841) to the unusual modes of onset and to many symptoms which may be early manifestations of the disease. It remains to emphasize these symptoms from the diagnostic point of view. Some, if not most, of these are the symptoms of complications, indicating that a complication is oftentimes the first evidence of the disease. Thus one of the most frequent of these early symptoms is furunculosis. Recurring crops of boils in a young adult or older person should always direct attention to the condition of the urine. And the same suspicion attaches to a tendency to carbuncles and phlegmonous processes. Women are frequently troubled with an intolerable itching of the labia for a considerable time before any other symptoms appear, and when to this itching is added an eczema or dermatitis of the adjacent parts, examination of the urine should never be omitted. Itching of the penis may occur, especially of the glans, the prepuce, or the meatus. The elder Flint states that he once made the diagnosis of diabetes from itching of the penis when no other symptom was present. Likewise, balanitis or phimosis may occur from the irritation caused in men of uncleanly habits by the saccharine urine.

In every case of gout the urine should be examined for sugar whether the symptoms indicate the presence of glycosuria or not, and the physician should not rest content with a single examination. It should be remembered in this connection that active paroxysms of gout and glycosuria do not coexist, but alternate. The presence of sugar in the urine, then, must be sought between the paroxysms rather than coincident with them.

Von Noorden's belief that in many cases of diabetes the real nature of the disease is masked for an indefinite time by obesity, or, rather, that obesity is at times an actual symptom of diabetes, the sugar being deposited in the tissues in the form of fat, instead of being lost through the kidneys, should be borne in mind. He recommends[1] testing the sugar assimilative power with glucose in obese individuals, especially when there is a history of diabetes in the immediate or a collateral

[1] *Centralblatt für klinische Medicin,* Leipzig, May 25, 1895.

branch of the family. To 15 persons in whom over-indulgence in carbohydrate foods was without effect he administered glucose, with the result that sugar appeared in the urine of 4 of them. Two of these 4 subsequently developed diabetes. Not a sufficient number of cases have yet been investigated to assign a diagnostic value to this test. Moreover, glucose passes readily into the urine of healthy persons when administered in amounts ranging from 50 to 250 grammes. (See Alimentary Glycosuria, p. 827.)

Jacobson emphasizes the fact that diabetes not infrequently begins as an obstinate gastric catarrh, recurring and rebellious to all treatment; and he confirms Unschuld's[1] statement of the frequency of cramps in the calves of the legs as an early sign. Unschuld observed these cramps in 26 per cent. of his cases during eight years, and in 1891 they occurred in 33 of 109 cases. The cramps usually come on in the morning, though sometimes at night. They may occur in all forms of diabetes except in the acute cases of young adults, and are especially significant when symptoms of weakness and weariness are present in addition. Unschuld believes these cramps have an important diagnostic value. In the same contribution he refers to indefinite nervous symptoms occurring early in some cases of diabetes, and advises examination of the urine under these circumstances.

Diabetes should be thought of if the teeth become carious without apparent cause or fall out because of an alveolar periosteitis. Obstinate neuralgias, especially of the third branch of the fifth cranial, of the crural and sciatic nerves, sometimes precede the other symptoms of diabetes. Some patients complain first of languor and debility, and without assignable cause. Men may become impotent, women may lose the sexual desire (Seegen), though the loss of the sexual desire usually belongs to the later stages of the disease. Sometimes the patient consults his physician for visual disturbances, unaware of the existence of the constitutional affection. Cataract is the most frequent of the early eye complications, though the possibility of the occurrence of others should not be overlooked. Tyson states that the patient may first notice a stiffening of his underclothing after the urine has evaporated, or that the urine leaves whitish spots on the shoes or clothing where a drop has fallen. Flint calls attention to the fact that bees are attracted to the urine when it is voided on the ground in the country.

All pale urines with a high specific gravity should excite suspicion, but it must be remembered that sugar may be present with the specific gravity below 1020. In every case where the specific gravity is more than 1025, whether the urine be pale or not, an examination should be made for sugar. In fact, it may be assumed that no examination of the urine is complete without a test for sugar, and especially is this true when the symptoms are of an indefinite nature. Many cases of diabetes in the early, and even sometimes in advanced, stages pass unrecognized through failure to examine the urine for sugar. And with the instruments and methods of precision now at the disposal of every physician the failure to recognize diabetes in cases where the amount of urine is increased can only result from negligence in not examining the urine for sugar.

[1] *Brit. Med. Journ.*, Aug. 11, 1894.

Diabetes with ataxic symptoms and loss of the patellar reflex may resemble locomotor ataxia. If symptoms of locomotor ataxia extend over a period of several months without glycosuria, diabetes may be excluded. In doubtful cases the history of the patient must be taken into consideration along with the symptoms. The Argyll-Robertson pupil does not occur in diabetes. Diabetes with ataxic symptoms is more common than locomotor ataxia with glycosuria.

It must be remembered that hysterical women and malingerers sometimes put sugar in the urine for the purpose of deception (Osler).

Methods for the determination of the presence of sugar in the urine will be found at the end of this article.

Prognosis.—The most important element in prognosis in diabetes mellitus is the *type* of the disease. In severe cases the prognosis is bad almost without exception. On the other hand, the prognosis is usually good in mild cases. In any case much depends upon the patient's compliance with the physician's directions. If a proper regimen is not instituted, severe types of the disease become progressively worse, and mild types may pass into the severe. The earlier diabetes is discovered, and the sooner the treatment begun, the greater is the hope of staying its progress or of ultimately effecting a cure.

Age.—Diabetes generally runs a severe course in children and young adults: the younger the patient the graver the prognosis. Tyson, however, has reported recovery in the case of a girl twelve years old. From forty years of age onward the prognosis becomes more and more favorable. The disease in older people is generally mild and readily amenable to treatment.

Heredity.—The prognosis is unfavorable where there is a history of severe cases of diabetes in the patient's family.

The *cause* of the diabetes, or at least its association with other conditions, will have a bearing on the prognosis. The prognosis is invariably bad when diabetes is associated with lesion of the pancreas. On the contrary, the prognosis is generally good in gouty and obese individuals or where the diabetes is of syphilitic or nervous (including injuries) origin. In gout and obesity moderate glycosuria may persist for years, constantly or intermittently, with little or no effect upon the health of the patient.

The development of serious *complications* necessarily adds to the gravity of the prognosis. The majority of cases of diabetes die from pulmonary tuberculosis or coma. Other fatal complications are gangrene, nephritis, carbuncle, phlegmons, and cerebral hemorrhage. Because of depressed vitality diabetics are especially susceptible to local infections and the various infectious diseases, and the intercurrence of one of these renders the prognosis more unfavorable, if not positively bad.

The excretion of *β-oxybutyric acid* in the urine generally signifies the speedy advent of coma. According to Von Jacksch, *diaceturia* is an unfavorable sign. In rare cases large amounts of *ammonia* in the urine, without the presence of β-oxybutyric acid, sometimes precede diabetic coma.

When a complication of diabetes necessitates *operative procedure* the prognosis is unfavorable. Wounds, surgical or other, in diabetes do

not heal kindly. There is generally a tendency to sloughing and gangrene. Moreover, diabetics do not take anæsthetics well.

The patient's condition may be made to improve by judicious advice in the majority of cases of diabetes. The glycosuria and other symptoms may even be made to disappear for a time, if not entirely. After treatment has been continued for a variable period the patient may sometimes return to ordinary diet without deleterious consequences. An actual cure may be effected in rare cases. But generally the disease is simply lurking under cover of improvement, ready for a fresh outbreak when there has been indiscreet indulgence in eating, improper regulation of habits as regards physical or nervous fatigue, or intense nervous strain from emotional causes. When the symptoms have not disappeared the patient's condition may be rendered worse by these same causes.

The prognosis as regards the continuance of life is favorable when diabetes mellitus has become transformed into diabetes insipidus.

TREATMENT.—It is doubtful if diabetes can be prevented. If there is a family history of diabetes and a tendency to the disease is suspected, the patient should be cautioned against over-indulgence in starchy and saccharine foods. It may become advisable to greatly reduce the quantity of such foods allowed, or actually withhold them at intervals for short periods of time. The predisposition to diabetes can be better anticipated, perhaps, in gouty and obese individuals; and in these cases it is especially advisable that excesses in eating and drinking be not committed in connection with sedentary living. It often happens, however, in gout and obesity that the tendency to diabetes is not suspected until sugar is discovered in the urine and the disease actually exists. The prophylaxis then becomes the dietetic treatment of the disease itself.

Dietetic Treatment.—The regulation of the diet is the most important part of the treatment of diabetes. It is based upon the fact that the intensity of the glycosuria corresponds in general with the quantity of sugar or sugar-forming substances (carbohydrates) in the food.

In the milder forms of diabetes a moderate amount of carbohydrates, and even sweets, may be consumed daily without the production of glycosuria, whereas if this amount be exceeded, glycosuria appears.

In severe cases the excretion of sugar continues even upon a purely nitrogenous diet, the sugar being formed from the albumin of the body or the albumin of the food.

In cases of intermediate severity the excretion of sugar ceases or is greatly diminished upon the withdrawal of carbohydrates and sugars from the food.

All dietetic tables for diabetes have as their principal object the selection of foods which contain the least possible amount of starch or none at all, and the elimination of sweets. The reason for withholding carbohydrates and sweets is not primarily for the purpose of causing the sugar to disappear from the urine. Glycosuria, *per se*, is not productive of harm, nor is hyperglycæmia itself now believed to account for the various constitutional and local disorders, as was formerly the case. The starches and sugars are withheld for the purpose of giving rest to the sugar-assimilative tissues, upon the physiological principle

that a cell or community of cells needs rest from the performance of any particular function when that function is impaired or perverted. During periods of rest a function is often restored to its full working capacity. In diabetes, then, the starches and sugars are withheld in part or entirely in the hope—and in many cases with the assurance—that the impaired or lost sugar-assimilative function will be improved or restored. All foods which contain a large proportion of starch should be withheld, or the quantity allowed regulated by the power of the individual to assimilate them. With regard to saccharine foods, it is best to eliminate them entirely, except such as contain only fruit sugar (lævulose). In every case the individual requirements of the patient must be considered in the regulation of the diet. In those already emaciated the quality and quantity of food must be so regulated, without regard to the intensity of the glycosuria, that no further loss of flesh occurs, and, if possible, so that there be an increase in weight. In the obese, on the other hand, it may even be desirable that flesh be lost, and a more rigid diet may be instituted with safety and positive benefit.

Cases of diabetes differ so widely from each other that each must form the subject of special study, and in the limited space at our disposal the directions for the management of cases must be general.

The sugar-assimilative power of a patient must be tested before any dietetic regimen can be intelligently established. This of course includes an estimation of the intensity of the glycosuria by a quantitative analysis of the urine for sugar. In addition, the daily excretion of urea should be determined and a qualitative examination for albumin be made. As a means of testing the sugar-assimilative power Von Noorden[1] recommends the employment of the following diet. The patient should not be put upon this diet without a previous gradual elimination of carbohydrates from the food:

Von Noorden's Standard Diet.

Breakfast.—Tea, 5 grammes, steeped in water, 200 cubic centimetres; ham, 150 grammes; 1 egg.

Lunch.—Cold roast beef, 200 grammes; fresh cucumber, 60 grammes, with 5 grammes of vinegar, 10 grammes of olive oil, and salt and pepper to taste; brandy, 20 grammes, with 400 cubic centimetres of Apollinaris; coffee, 60 cubic centimetres, without milk or sugar.

Dinner.—Clear bouillon, 200 cubic centimetres; beef, 250 grammes (weighed raw), basted with 10 grammes of butter; green salad, 80 grammes, with 10 grammes of vinegar and 20 grammes of olive oil or three tablespoonfuls of some well-cooked green vegetable; 3 sardines *à l'huile;* cognac, 20 grammes, with 400 cubic centimetres of Apollinaris.

Supper.—Two eggs (raw or cooked); Seltzer water, 400 cubic centimetres.

"This standard diet is free from carbohydrates: it contains very nearly 200 grammes of albumin (with 32 grammes of nitrogen) and about 135 grammes of fat. As soon as the urine has been free from

[1] *Twentieth Century Practice*, art. "Diabetes," vol. ii.

sugar for two or three days under this diet, gradually increasing amounts of starch up to 20, 50, and 100 grammes are added. I sometimes give for this purpose white bread, containing 55 per cent. of starch, and sometimes Albert biscuit, which contains 75 per cent. of starch. As soon as, under these increasing additions of starch, sugar reappears in the urine, we get the formula,

"Tolerance = standard diet + x grm. starch."

Von Noorden employs this diet in the following manner:

"(*a*) For a few days gradual withdrawal of carbohydrates from the food.

"(*b*) For five days the standard diet.

"(*c*) If the urine now becomes sugar-free, a progressively increasing quantity of starch is added to the standard diet until glycosuria returns."

The data to be obtained from the use of this diet are chiefly of value in those forms of diabetes in which the sugar disappears from the urine upon the withdrawal of the carbohydrates from the food. The diet should be employed at intervals during the progress of a case to discover any changes that may have occurred in the patient's condition. Having determined the quantity of starch which a patient can assimilate, the diet-sheet should be arranged accordingly. When carbohydrates are allowed, it is better that the daily amount be distributed through the twenty-four hours rather than taken at once. Glycosuria is not so likely to follow.

As a matter of fact, it is rarely advisable to withhold carbohydrates altogether, even in severe cases, except for short periods at intervals during the year. An exclusive meat diet has been thought to favor the development of diabetic coma. Moreover, patients rebel against the exclusion of carbohydrates, and particularly against the exclusion of bread. The natural craving for bread is intensified by the disease itself. The tissues cry out for the food they need but cannot assimilate. The demand may become so urgent that patients will resort to all forms of deception to obtain the coveted food, and especially since diabetes often causes a blunting of the moral sense. This fact must be borne in mind, and the surreptitious eating of bread should be suspected when a marked increase in the intensity of the glycosuria occurs without assignable cause.

When a patient is to be placed upon the diabetic diet it has been found easier to begin at once, and not with a gradual lessening of the amount of carbohydrates allowed him.

The following diet-sheets have been prescribed by Ebstein, Düring, and Von Noorden. They may be strictly adhered to or taken as guides in the management of any particular case:

Ebstein's Diabetic Diet.[1]

Early Breakfast.—One cup of coffee or tea (black), without milk and sugar. White bread toasted, 30 to 50 grammes, or brown bread well buttered—butter, 20 to 30 grammes. The yolk of an egg, a little

[1] Cited by Thompson, *Practical Dietetics*, p. 660.

fat ham, or some German sausage if required. If any food be needed between this meal and dinner, let it be a cup of broth with the yolk of an egg.

Dinner.—Broth, with yolk of egg or marrow (the marrow bone is boiled for half an hour to solidify the marrow). Peptone may be added to the broth. Meat, 180 grammes, free from bone, roasted, boiled, or stewed—beef, mutton, pork, veal, fowl, or venison (fat meat preferred). Gravies to be made with cream or yolk of egg, not flour. Fish to be served with melted butter. Vegetables prepared with much fat; *purées* of leguminous plants; salads dressed with vinegar and oil. The food should be well salted and spiced. After dinner a cup of coffee or tea.

Supper.—One cup of tea or broth. Meat (roasted) or cheese, or an egg or fish, caviare. Bread, 30 to 50 grammes, with butter, 20 to 30 grammes. Apples, pears, and stone-bearing fruits are allowed in small quantities.

Beverages.—Ebstein forbids absolutely the use of beer, limits the use of spirits, and allows half a bottle of wine daily. If the patient can digest milk well, it is allowed in moderate doses, and cream is especially recommended.

Düring's Diet for Diabetes.[1]

Early Breakfast.—Milk, with a little coffee, but no sugar (lime-water to prevent milk from souring in the stomach); stale white bread *ad libitum*, or, if not well borne, oatmeal, barley, or rice gruel made with water, a little salt, but no butter.

Second Breakfast.—White bread, stale and well baked; an egg lightly boiled; rice or oatmeal gruel, with or without milk, a breakfast-cupful; or half a glass of good red wine (with water in certain cases).

Dinner (taken between two and three o'clock).—Soup, with rice, barley, or oatmeal; meat, roasted, 250 grammes (game, ham, and smoked meats, as free from fat as possible, are permissible); no condiments, *no fatty sauces; compôte* of dried apples, plums, cherries; dried peas, or white beans in some cases; green vegetables, asparagus, French beans, carrots, cauliflower, cabbage (boiled in water with salt, not with fat or stock); dessert of a little raw fruit, apples, cherries, with one small glass of red wine diluted with water.

Supper (about 7 P. M.).—Gruel of barley, oatmeal, or rice, with salt (but no butter), and strained. In some cases may be made with milk. Ice or iced water to relieve thirst between meals.

Düring believes that the starches in his diet have been so changed in the boiling process that they do appear in the urine as sugar. A marked difference between Ebstein's and Düring's diets is the elimination of fats from the latter as far as possible.

Von Noorden's Diabetic Diet.[2]

The following diet is recommended only during periods of strict abstinence from carbohydrates. It is only "a sample bill of fare," and

[1] Cited by Thompson, *Practical Dietetics*, p. 661.

[2] *Loc. cit.*

may be varied from time to time by the use of other carbohydrate-free articles of food:

First Breakfast (8 o'clock).—Ham, 100 grammes; 1 cup of tea; 1 glass of cognac.

Second Breakfast (10.30 o'clock).—Two eggs, fried in 10 grammes of butter.

Luncheon (12.30 o'clock).—Cold roast meat, 150 grammes; mayonnaise, made with the yolk of one egg and one spoonful of oil; raw cucumber, 5 grammes, vinegar, 1 spoonful of oil, salt, and pepper; Gorganzola cheese, 15 grammes; half bottle of Moselle; coffee, one cup, with one teaspoonful of cream.

Tea (5 o'clock).—Tea, one cup; one boiled egg; one glass of cognac;

Dinner (7.30 o'clock).—Bouillon, one cup, with marrow, 15 grammes; boiled salmon, 80 grammes; asparagus, $\frac{1}{3}$–$\frac{1}{2}$ pound, with butter, 20 grammes; smoked ox-tongue, 30 grammes; capon, 100 grammes; salad with vinegar, 5 grammes, and 1 spoonful of oil; Burgundy, one-half bottle.

Nightcap (10 o'clock).—Cognac, one glass with Seltzer water.

This diet is intended for use in moderately severe and severer forms of diabetes. Van Noorden insists upon the addition of fats to supply the deficit in heat-producing foods caused by the withdrawal of carbohydrates from the food. In moderately severe cases he recommends that this diet be employed "at least twice, and if possible three times, in the year," and in very severe cases quarterly. In the intervals carbohydrates are given in amount equivalent to four ounces of good wheat bread, irrespective of the intensity of the glycosuria, and, if the tolerance of the patient for carbohydrates is higher after abstinence, they may be given more freely.

Foods allowed in Diabetes (Thompson[1]).

"*Soups and broths* made of meat of any kind without vegetables, ox-tail and turtle soup, gumbo, curry.

"*Eggs* in any form.

"*Crustaceans*, crabs, lobsters, shrimps.

"*Fresh fish* of all kinds and fish-roe. Caviare, anchovies. Salt fish, cod, mackerel, and herring, may be allowed unless they increase thirst too much.

"*Fresh meat*, fowl and game of all kinds. Ham, bacon, smoked beef, tongue, sweetbreads, kidneys.

"*Fats.*—Olive oil and all animal fats and oils, such as butter, cream, cod-liver oil, bone marrow. Some authorities, however, exclude all fats. Senator objects to them on the ground that they form glycerin. Cantani excludes butter because it may contain some milk sugar. But usually such rigidity is unnecessary. In some diabetic patients the power of fat digestion is apparently increased, so that they tolerate larger quantities than in health.

"*Vegetables.*—Spinach, cress, sorrel, chicory *romaine*, dandelions, beet-tops, horse-radish, radishes, celery, sea-kale, artichokes, vegetable

[1] *Practical Dietetics*, p. 651.

marrow, okra, lettuce, endives, pickles, cucumbers, gherkins, cranberries. The following vegetables are allowed by some writers, prohibited by others: Green French string-beans, asparagus, summer squash, onions, leeks, carrots, cauliflower, cabbage, sauerkraut, coleslaw, kohl-rabi, parsley, parsnips, egg-plant, artichokes." . . . .

"*Miscellaneous.*—Kidneys, tripe, pigs' feet, truffles, mushrooms, sweetbreads, terrapin.

"*Cheese*, cream cheese, milk curds.

"*Jellies* made of gelatin, calf's foot, with wine, but unsweetened except with saccharine, coffee jelly, lemon jelly. Van Abbott recommends an ivory jelly made from ivory.

"*Fruits*, if acid, not sweet. In England, where gooseberries are eaten much more than in this country, they, as well as apples, red currants, and sour cherries, are sometimes allowed. Many of these fruits contain more lævulose than grape sugar. Sour oranges, lemons, grape fruit, olives, sour apples, peaches in brandy (without sugar), raspberries, and strawberries are allowed by some, but are usually forbidden. Muskmelons and watermelons may sometimes be eaten.

"*Nuts.*—Oily nuts, such as almonds, walnuts, Brazil nuts, hazelnuts, filberts, pecan nuts, butternuts, cocoanuts.

Forbidden Foods.

"*Sugar* in any form in syrups, molasses, confectionery, jams, and sweets of all kinds. Honey is forbidden, for it contains both dextrose and lævulose.

"*Starches.*—All the elementary forms of starchy and farinaceous food, such as rice, sago, tapioca, arrow-root, oatmeal, cornmeal, hominy, samp, buckwheat, barley, semolina, macaroni, spaghetti, vermicelli. All pastry, cake, puddings, pies of every description—in short, everything made of flour excepting a little bread, as specified above.

"*Vegetables.*—Potatoes, beets, carrots, parsnips, turnips, peas, beans (except string-beans), lentils, cauliflower, broccoli, Brussels sprouts, rhubarb. Some writers, like Dujardin-Beaumetz, occasionally allow a well-baked potato in mild cases. It contains only 15½ per cent. of starch, or one-fifth as much as rice and one-half as much as peas and beans.

"*Shellfish.*—The soft parts or livers of clams, oysters, and mussels contain glycogen. By some these foods are entirely forbidden, but many diabetic patients can take them occasionally without injury.

"*Liver* of all animals (it contains glycogen), *pâte de foie gras.*

"*Fruits.*—In regard to the use of fruits there is some difference of opinion. Sweet fruits, such as figs, dates, plums, prunes, bananas, apricots, all preserved, candied, or sugared fruits, must be absolutely interdicted. Pears, melons, and berries are forbidden by many, but allowed by others.

"*Nuts.*—Chestnuts, peanuts."

The patient should be allowed sufficient *water* to satisfy his craving. The urgency of the thirst corresponds with the intensity of the glycosuria, and, like it, is only a symptom. As the diseases improves under appropriate treatment the demand for liquids will become less pro-

nounced. Acidulated drinks may be given in any case where it is desired to allay the thirst to some extent.

Unless *alcohol* is judiciously used it may prove injurious. Only the lighter "dry" wines should be allowed in the majority of cases, and they only in moderation. A little whiskey or brandy may be taken by patients past fifty if desired. Flint allows Bass's ale, and Von Noorden allows one or two glasses of beer a day in the milder cases.

All sweet, and especially sparkling, wines should be absolutely interdicted. No liqueurs or "mixed drinks" should be allowed under any circumstances.

Substitutes for Bread.

As stated above, bread is the most difficult of all foods for the diabetic to give up. Many substitutes have been offered, but all have proven more or less unsatisfactory. According to many of the best authorities, it is better to allow small amounts of ordinary bread daily, except during periods of strict abstinence from carbohydrates. Dujardin-Beaumetz and Osler advise the use of potatoes or potato meal in small quantities—five ounces. The more important of the substitutes are gluten bread, almond bread, bran bread, and inulin biscuits.

Gluten Bread.—Bouchardat suggested the use of gluten flour in diabetes in 1841. It is made from ordinary flour by washing out the starch. Unless special care, however, is exercised in the washing process much starch remains. In fact, few gluten flours are reliable. They often contain a large proportion of starch—as much as 60 to 70 per cent., according to Harrington. Tyson says he has actually seen glycosuria disappear upon the withdrawal of gluten bread from the diet. Gluten flour may be made into bread or gruel. The bread is tough and doughy and difficult of mastication. Patients soon tire of it.

James Stewart's Gluten Bread.—"Take one quart of sweet milk or milk and water, one heaping teaspoonful of good butter, one-fifth of a cake of compressed yeast beaten up with a little water, and two eggs well beaten. Stir in gluten flour until a soft dough is formed, knead as in making ordinary bread, put in pans to raise, and when light bake in a hot oven."

Almond bread was introduced by Pavy as a substitute for ordinary bread. The almonds are ground to a powder, and the powder put into boiling water to which a little tartaric acid has been added to remove the emulsion.

Seegen gives the following formula for the preparation of almond bread:[1] "Beat a quarter of a pound of blanched sweet almonds in a stone mortar for about three-quarters of an hour, making the flour as fine as possible; put the flour thus obtained into a linen bag, which is then immersed for an hour and a quarter in boiling water acidulated with a few drops of vinegar. The mass is thoroughly mixed with three ounces of butter and two eggs; the yolks of three eggs and a little salt are added, and the whole is to be stirred briskly for a long time. A fine froth made by beating the white of the three eggs is added. The whole paste is now put into a form smeared with melted butter and baked by a gentle fire."

[1] Tyson: *Pepper's System of Medicine*, art. "Diabetes," vol. ii.

Bran Bread.—Ordinary wheat bran is freed from starch by a process of washing similar to that employed in preparing gluten flour. The product, like gluten flour, often contains a considerable proportion of starch unless special care is taken in its manufacture. It may be made into bread, biscuit, or cakes, with eggs, milk, and butter. Preparations of bran are tasteless, but are slightly nutritious because of the small proportion of nitrogenous matter and fats contained in them. An objection to the use of bran bread is that it may cause diarrhœa through mechanical irritation of the alimentary tract by the particles of cellulose. A desirable laxative effect may often be produced where there is a tendency to constipation.

Camplin's formula for making bran bread is as follows:

Camplin's Bran Bread.[1]—"Boil one quart of wheat bran in two successive waters; wash in a sieve with hot water until the water runs through clear. Squeeze in a cloth after each washing. Spread thinly on a dish and dry in a slow oven. Grind in a fine mill, and sift by brushing through a very fine sieve. Grind the residue again and sift. Take of the powder three ounces, three new-laid eggs, butter two ounces, and half a pint of milk. Mix the eggs with a little of the milk, warm the butter with the rest. Stir the whole and flavor with nutmeg or ginger. Bake in thin cakes in a quick oven for half an hour."

Inulin biscuits have been recommended by Külz as a food in diabetes. Inulin is obtained from the root of Iceland moss. The reader is referred to special works on Dietetics for directions as to its use.

Saccharine.—The elimination of sweets from the diet is oftentimes as great a privation to sufferers from diabetes as the withdrawal of bread. Glycerin was formerly employed as a substitute for sugar, but proved objectionable because of its laxative action when taken in any quantity. Saccharine, a coal-tar product, has been successfully used during the last few years. It soon becomes distasteful to some patients, however. When perfectly pure, saccharine is five hundred times sweeter than cane sugar, but the ordinary commercial variety is only three hundred times as sweet. It may be obtained in the form of tablet triturates, one-half and one grain each. One tablet is sufficient to sweeten a cup of tea or coffee. Saccharine may be used as a substitute for sugar in the preparation of any article of food. It passes through the body unchanged, being excreted entirely in the urine, and "has no effect upon the system whatever."[2]

Diabetin.—Saccharine cannot, however, fill the place of sugar, because sugar is a food and saccharine is not. In view of this fact, fruit sugar (lævulose, diabetin) has been recommended as a sweetening agent, since it is a natural food. Recent investigations have shown that when fruit sugar is given to patients with diabetes in definite moderate quantities the intensity of the glycosuria is not increased (Worms; Minkowski).

Milk Diet.—Donkin proposed an exclusive milk diet for diabetes in 1868. Its effects have been beneficial in many cases. Skim milk is to be recommended because it is easier of digestion. Tyson advises its administration in the following manner: Eight ounces every two hours from 7 or 8 A. M. to 7 or 8 P. M., or begin with a smaller quantity and rapidly increase to eight ounces. Three or four quarts, or, if necessary,

[1] Thompson: *op. cit.*, p. 655. [2] Helbing: *Modern Materia Medica*, 4th ed., 1895.

more, should be given in the twenty-four hours. In some cases it may be more agreeable to substitute the curd for a portion of the milk. The curd may be seasoned with pepper and salt to taste. Peptonized milk, buttermilk, or koumyss may be used instead of skim milk.

Authorities differ as to the efficacy of the milk treatment. Some prohibit the use of milk altogether, as likely to increase the glycosuria. It is known that the limit of tolerance of milk sugar is soon reached in adults, and that the excess then passes into the urine (Howell).

In any case where the milk diet is begun it should be kept up for six weeks. Few patients, however, will submit to the exclusion of all other foods for more than a few days.

Patients should be brought as little as possible in contact with the selection, except in a general way, and preparation of their food, because of the loathing that is likely to arise, and because of the mental depression that such constant attention to diet will produce.

No diet will produce immediate effects upon the patient's urine or general condition. Days, and sometimes longer, must elapse before any change will be noted.

Diabetes is usually severe in children and young adults, and in these cases a rigid diet should be strictly adhered to.

When in the course of diabetes any complication arises which would indicate a change of diet, the case should be treated according as the complication or original disease is the more urgent. A meat diet is harmful in nephritis. A milk diet may be advantageously employed in these cases.

When the patient's life is probably of short duration, it will be charitable, to say the least, not to enforce too strict a regimen.

It is scarcely necessary to say that frequent examinations of the urine are essential to a thorough understanding of a patient's condition, or that oscillations in the intensity of the glycosuria indicate changes, for the better or worse as the case may be, in his condition.

Hygienic Treatment.—Though the dietetic treatment occupies first place in the management of any case of diabetes, the hygienic treatment is always a valuable adjuvant, and sometimes assumes an importance coequal with the regulation of the diet.

Patients suffering from diabetes should lead uniform lives. They should be relieved as far as possible from all sources of annoyance or anxiety, either of a domestic or business nature, and reside in a dry, moderately warm, equable climate. Damp, changeable climates are distinctly injurious. A long sea-voyage may be advisable in some cases. Patients should not subject themselves to nervous strain or emotional excitement. It will be recalled that nervous strain and emotional excitement are believed to stand in a causal relation to some cases of diabetes. In any case they often cause the return of a glycosuria which has disappeared or an increase in the intensity of an existing one.

The proper performance of all the bodily functions is of prime importance. The patient must obtain the necessary amount of sleep, the food must be digested properly, the bowels must be kept regular, and the skin must be carefully protected.

If natural sleep cannot be obtained, resort must be had to the use of

hypnotics. In this connection reference is made chiefly to the insomnia, which results from nervous causes rather than from frequent disturbances of sleep to empty the bladder. Trional in 15- to 30-grain doses immediately before retiring; sulphonal in 20-grain doses, triturated with cane sugar and dissolved in hot milk or coffee, two hours before retiring; or potassium bromide in 15- to 60-grain doses, may be employed as hypnotics.

Digestive disturbances are not common in diabetes, despite the tax made upon the digestive apparatus. It must be remembered, however, that obstinate gastritis may usher in the disease. If later in the disease the digestion becomes deranged, the cause of the derangement must be determined, as hyperacidity, subacidity, gastritis, etc., and the condition treated by the administration of acids, alkalies, pepsin, or other appropriate means. Intestinal fermentation may be corrected by salol in 5-grain doses three times a day; by carbolic acid, 1 minim three times a day; by creasote, 1 minim three times a day; or by some other intestinal antiseptic if these fail or are otherwise objectionable.

Constipation may often be relieved by regulation of the diet and amount of exercise. Foods which contain particles of cellulose, such as bran bread or ordinary brown bread if greater freedom be allowed in the use of carbohydrates, often have a laxative effect from mechanical irritation of the alimentary tract; or one or two *sour* apples, eaten with the peel just before retiring, often produce the same effect. The importance of a regular amount of exercise in maintaining proper peristalsis need only be referred to. If dietary measures and exercise fail to regulate the bowels, laxatives should be employed. Calomel, in $\frac{1}{4}$- or $\frac{1}{2}$-grain doses every half hour until a grain or two have been taken, may be used once or twice at the start, and afterward the following prescription ordered for several weeks or even longer:

℞. Tincturæ nucis vomicæ, ♏v;
Extracti rhamni purshianæ fluidi, ♏v–x;
Misturæ rhei et sodæ, q. s. ad ℥j.
M. et sig. A teaspoonful in a claret-glassful of water before meals.

The rhubarb and soda may be used alone, either in the form of the official mixture or in the form of compressed tablets, which are on the market. Von Noorden recommends the following combination:

℞. Citric acid, 5 parts.
Glycerin, 30 "
Water, 1000 "

One or two pints ($\frac{1}{2}$–1 litre) to be taken daily. Constipation should not be allowed to continue, since it is believed to lead to diabetic coma or a form of auto-intoxication resembling it.

If there is diarrhœa, its cause should be determined before treatment is instituted. Intestinal fermentation may be corrected as indicated above. In any case a safe procedure is to clear out the bowels with calomel, or a dose of castor oil administered floating on the surface of a glass of ginger ale, and the subsequent administration of astringents and opium or opium alone.

The skin should receive especial care. Many cutaneous complications may be prevented by proper precautions. The skin should be kept scrupulously clean, the temperature of the bath to be determined by the patient himself. A cold bath in the morning, followed by friction with a coarse towel, is preferable, because of its stimulating effects upon the cutaneous circulation. The greater the circulatory activity the greater will be the amount of perspiration, other things being equal. Tepid or warm baths may be substituted where the cold cannot be borne. Flannel or silk should be worn next the skin the year round to prevent chilling of the surface. Surf-bathing is too violent as a rule, and may prove injurious from the consequent exhaustion.

The value of *exercise* in diabetes has been shown by a number of observers, notably Külz. The amount of sugar in the urine is often lessened, since some of it, which otherwise would escape from the body unused, is consumed as a result of the muscular contraction. Aside from this, the general effects of exercise are beneficial All the functions of the body are raised to a higher working capacity. It must be emphasized, however, that too much exercise is injurious. Diabetic coma has followed physical exhaustion. The patient's strength must not be taxed beyond, or even to, his power of endurance. A good general rule for the patient is not to take so much exercise that he is not refreshed by a rest of fifteen or twenty minutes in the lying posture. Any form of exercise that is not violent may be recommended—*e. g.* walking, riding, driving, golf, cycling, etc.

The use of *mineral waters and baths* is attended with favorable results in many cases of diabetes. They are of especial advantage in diabetes of gouty or lipogenous origin, though other cases may be benefited. Gouty glycosuria improves in proportion as the gout is improved. In other cases it is difficult to determine how much benefit accrues from the hydrotherapy and how much from other causes—*e. g.* change of scene and air, freedom from care, regular exercise, regulation of the diet, etc. All patients will follow any regimen better away from home than at home, where they are subject to counteracting influences. When pátients have the means and are not in a too depressed physical condition a "cure" (lasting usually twenty-one days) may be tried at some springs. The subject of mineral waters, both internally and as baths, will not be considered further, because such treatment can only be successfully carried out at bathing resorts.

Medicinal Treatment.—The long list of drugs which have been proposed from time to time for the treatment of diabetes is evidence of the scant hope of benefit medicinal treatment offers. The general consensus of opinion gives the preference to opium and its alkaloids, morphine and codeine. The alkaloids usually give the better results because of the constipating action of the opium itself, and of them codeine is to be preferred. The only objection to codeine is its cost. It is more expensive than morphine. Under the action of either a surprising reduction in the intensity of the glycosuria sometimes occurs. The diminishing glycosuria, however, is but one indication of the beneficial effects of the drugs. The real benefit is the control exercised upon the perverted sugar-assimilative tissues, either directly or, as more probable, through the agency of the nervous system. Codeine may be adminis-

tered in doses of ½ grain three times a day, gradually increased to 2 grains three times a day. Morphine may be given in correspondingly large doses. No evil effects follow the use of the alkaloids of opium, except some constipation from morphine, and when it is desired they may be withdrawn without serious inconvenience to the patient. The opium habit is rarely established.

Potassium bromide also is a valuable remedy, chiefly in cases in which the neurotic element is pronounced. It is supposed to act as a general nervous sedative. A reduction in the daily excretion of sugar sometimes follows its continued administration.

Among other drugs which have been recommended are—ergot, Clemen's liquor arsenici bromati, arsenous acid, jambul, quinine, phenacetin, antipyrine, the salicylates, lactic acid, and uranium nitrate.

It is significant that all drugs give better results in connection with dietetic and hygienic treatment.

General tonics and stomachics may be given when indicated.

Recently attempts have been made in diabetes believed to be of pancreatic origin to cure, or at least improve, the disease by means of pancreas-grafting and the ingestion of raw pancreas or of extracts of the gland in alcohol, glycerin, and water. The results have proved unsuccessful, but experiments along this line of treatment should be encouraged. It would appear that ingestion of the raw gland or its extracts does not offer the same amount of hope as pancreas-grafting. It remains for future investigation to determine what the ultimate success of pancreas-grafting will be in these cases.

Treatment of Complications.—The treatment of the complications of diabetes is not essentially different from their treatment as independent diseases, and will not be entered into in this place.

The little that can be done for *diabetic* coma, however, calls for especial consideration. When the coma has fully developed there is scarcely any hope of recovery. Hypodermic injections of camphorated oil (camphor 1, olive oil 8) and ether should be given to sustain the heart. Recently transfusion with warmed normal salt solution (0.7 per cent.) has given results which recommend further trial. The treatment with large doses of alkalies, such as sodium bicarbonate, on the theory of an acid intoxication, has proved unsuccessful.

By way of prevention of the coma the conditions which have preceded it in many cases should be corrected or not allowed to occur: constipation should be overcome, physical or nervous fatigue should be avoided, and complete elimination of carbohydrates from the diet should not be continued for too long a period.

Operations.—Caution should be exercised in undertaking operative interference in any case of diabetes. From an extensive study of operations upon diabetic patients Reynier [1] has reached the following conclusions: That operation is perfectly safe in some subjects, while in others the most insignificant operation is attended with a fatal result; that diabetes with extensive arterial sclerosis is the safest form in which to operate; that nervous and pancreatic forms are the most dangerous in which to operate; that operation should not be undertaken in cases where the reflexes have been lost, except from most urgent necessity;

[1] *Revue de Thérapeutique medico-chirurgicale*, Paris, No. 3, 1894.

and that in no case should an operation be performed when the daily excretion of sugar is greater than 15 or 20 grammes. He also recommends the employment of asepsis in preference to antisepsis, because of the irritating properties of antiseptic agents.

Tests for Sugar.

Fermentation Test.—A little baker's yeast is shaken with the suspected urine in a test tube, and afterward the tube is completely filled with the urine. The mouth of the tube is then covered with the thumb, inverted in a tumbler partially filled with urine, and the whole is set aside at room or incubator temperature. If the urine contains sugar, carbon dioxide will be formed and collect after a varying time, depending upon the temperature, at the top of the tube, forcing the urine down. The fermentation test is a positive test for sugar, depending upon alcoholic fermentation, and may be employed in any case where there is reason to doubt the accuracy of other tests. Moreover, it is a very delicate test, responding to 0.1 per cent. of contained sugar. When using this test it is well to perform a control experiment with normal urine, since with normal urine a few gas bubbles are formed and collect at the top of the tube. Instead of the tumbler and test tube, a fermentation saccharometer or similarly constructed tube may be used.

Quantitative Estimation by Fermentation.—The fermentation saccharometer devised by Max Einhorn gives results within 0.1 per cent. of the amount of sugar present, and requires less of the practitioner's time than the quantitative estimation by the titration method. It is, therefore, to be recommended in general work. To use it 10 c.c. of the urine to be tested are shaken with a small quantity of yeast (about one-eighth of a cake of the commercial compressed yeast), and poured into the tube, held at an angle so that all the air is driven out. The tube is then set aside at ordinary room temperature for twenty-four hours. The carbon dioxide evolved accumulates at the top, forcing the urine down, and the percentage of sugar contained may be read off on the side of the long arm.

If the urine contains more than 1 per cent. of sugar, it will have to be diluted, since the saccharometer is graduated to only 1 per cent.

Fehling's Test.—The reagent most commonly employed in clinical work for the detection of sugar in the urine is that known as Fehling's solution. It consists of two solutions, an alkaline solution and a copper solution, kept in separate well-stoppered bottles and mixed in equal proportions just before using. The mixed solution deteriorates on keeping. This test is based upon the principle that copper oxide is reduced to its suboxide in the presence of grape sugar in boiling alkaline solutions. The alkali solution and the copper solution are usually made according to the following formulæ :

A. Alkali solution :

Sodium tartrate,	gm. 173 ;
Caustic soda, specific gravity 1034,	" 100 ;
Water,	" 500.

B. Copper solution:

Copper sulphate (pure crystals),	gm. 34.64;
Water,	" 500.

In applying the test 5 c.c. of each solution are poured into a test tube, and the test tube is shaken until the precipitate formed is entirely dissolved. The mouth of the test tube should not be covered by the thumb or hand and the tube inverted to mix the solutions, as is frequently done. When the solutions have been thoroughly mixed the liquid is boiled over an alcohol lamp or Bunsen's burner. If a precipitate forms upon boiling before the addition of any urine, the solution is useless for the detection of sugar. When the liquid has been brought to the boiling-point, a few drops of the suspected urine are added and the boiling continued. If the urine contains much sugar, a yellowish or reddish precipitate will form. If after the first addition of urine and subsequent boiling no precipitate forms, more urine should be added, always a little at a time, until a quantity of urine equal to that of the solution has been used. After the final addition of urine, if no precipitate has been thrown down, it will be well to let the test tube stand until it cools or to cool it under flowing water. Sometimes the precipitate is formed only after cooling. If no precipitate forms, but instead the solution assumes a dirty greenish, opaque appearance, it indicates the presence of sugar in small quantity.

Fehling's test does not always give positive results. Other substances than grape sugar possess the property of reducing the solution (see Transient Glycosuria, p. 826). Hence in doubtful cases this test should be supplemented by a more positive one—*e. g.* the fermentation test. If the urine contains albumin, it should be coagulated by heat and filtered out before testing for sugar.

Quantitative Estimation with Fehling's Solution.—Titration Method.—While the quantity of sugar contained in a given specimen of urine is indicated in a general way by the readiness with which the precipitate is formed and the amount thrown down, the actual quantity can only be estimated by a more careful process.

Ten cubic centimeters of Fehling's solution, made according to the above formula, will be completely reduced by 0.05 gm. of grape sugar. With this as a basis the quantitative estimation should be conducted as follows:

Some of the suspected urine is diluted with from six to ten times its volume of water, the degree of dilution depending upon the approximate amount of sugar present as determined by the specific gravity and qualitative test. The diluted urine is placed in a graduated burette.

Ten cubic centimetres of the Fehling's solution are diluted with 40 c.c. of water and the whole poured into a Florence flask or porcelain crucible.

The diluted Fehling's solution is brought to the boiling-point, and a little of the diluted urine is added from the burette from time to time, continuing the heat until a red or yellow precipitate falls and the blue color of the Fehling's is discharged. Upon the exact determination of this point—that is, the complete reduction of the copper—the accuracy

of the test depends. When this has been done the following formula will give the percentage of sugar in the urine:

$$\frac{x \text{ dilution of urine (in volumes)} \times 5}{x \text{ c.c. of diluted urine used}} = x \text{ per cent. of sugar;}$$

for example, if the urine has been diluted ten times and 10 c.c. of the diluted urine have been used, then

$$\frac{10 \times 5}{10} = 5 \text{ per cent. of sugar.}$$

If the test has been carefully performed, the result will be sufficiently accurate for practical purposes. When more accurate results are desired a little ($\frac{1}{2}$ to 1 c.c.) of the diluted Fehling's is removed from the vessel as soon as the precipitate begins to fall, is filtered to remove the precipitate, acidulated with acetic acid, and a dilute solution of potassium ferrocyanide is added. A brown color indicates the presence of unreduced copper. If copper is found, a further addition of diluted urine is made, and the Fehling's solution boiled until the copper has been entirely reduced, as shown by the acetic-acid-potassium-ferrocyanide test. If unreduced copper is not found in the first instance, the test has been vitiated by the addition of too much urine, and must be repeated.

Phenyl-hydrasine Test. — Phenyl-hydrasine forms characteristic needle-like crystals of phenyl-glucosazon with grape sugar, and hence is used for the detection of grape sugar in urine and other fluids. It is the most reliable practical test for sugar except the fermentation test, and is a test of extreme delicacy. Von Jaksch recommends the following method of application: A small quantity of hydrochlorate of phenyl-hydrasine ("twice as much as will lie on the point of the blade of a knife") and a little larger quantity of sodium acetate are added to 6 or 8 c.c. of urine in a test tube, and the urine warmed. It may be necessary to add a little water to bring the salts into solution. Then the test tube is placed in boiling water for twenty to thirty minutes, and afterward in cold water. If sugar is present, a yellowish deposit will form, which under the microscope will show the characteristic crystals lying singly or in clusters. The phenyl-hydrasine test is applicable to albuminous urine, though if the quantity of albumin present be large, it will be well to coagulate it by heat and to filter it out.

Nylander's Bismuth Test.—Nylander's test is a modification of the test proposed by Böttger. The reagent employed is prepared after the following formula:

Sodium tartrate,	gm. 4;
Caustic soda,	" 10;
Water,	" 100.
Dissolve and add	
Bismuth subnitrate,	gm. 2;

warm to about 50° C., and filter when cool.

In applying the test 1 c.c. of the reagent is added to 10 c.c. of the suspected urine in a test tube and the mixture boiled. If the urine contains sugar, metallic bismuth will be precipitated and the liquid become black. As in the case of Fehling's test, this test is open to the objection that other substances than sugar will give the reaction—*e. g.* albumin, derivatives of rhubarb, melanin, and other reducing substances. A negative result, however, is proof that the urine does not contain sugar. This test is very delicate, responding to 0.1 per cent. of sugar.

Polarimeter.—Grape sugar rotates polarized light to the right, and hence is said to be dextro-rotatory. The polarimeter may be used both for the qualitative and quantitative estimation of sugar. Circumpolarization, however, pertains to the laboratory rather than the physician's office. The instrument is expensive and the examination tedious. Descriptions for its use will be found in text-books of clinical diagnosis and physiological chemistry.

INSOLATION.

By ALEXANDER LAMBERT, M. D.

Synonyms.—Sunstroke; Heatstroke; Thermic fever; Coup de soleil; Coup de chaleur; Hitzshlag; Sonnenstich; Ictus solis; Insolatio.

Definition.—Insolation is a disease whose main features are, in its milder forms, intense exhaustion with or without a rise of temperature, and in its severer forms an enormous rise of temperature and coma, probably caused by an acute auto-intoxication due to the presence in the blood of toxic decomposition products or toxic substances produced at the unusually high temperature, the exact nature of these substances being at present unknown.

Etiology.—Insolation occurs with greater frequency in the tropics, especially where the climate is damp. In the United States it occurs during the summer in the Mississippi Valley, around the southern shores of the Great Lakes, and especially along the Atlantic seacoast. In the West and South-west it is rare, owing to the dryness of the climate.

All causes which diminish the resistance of the body predispose to sunstroke. Alcoholism unquestionably is one of the strongest predisposing causes—not only chronic alcoholism, but even a single alcoholic excess. All excesses, such as over-exertion producing extreme fatigue, sexual excesses, predispose to an attack. Patients suffering from chronic ailments, especially elderly people, even those who have taken no bodily exercise and have remained indoors, are sometimes overcome and suffer from attacks of insolation. Cases of true insolation are not common among children, though even the very young are not exempt. Men are more frequently attacked than women, because their occupations more frequently subject them to the different forms of exposure to heat and require of them greater physical exertion, and also because men are more given to alcoholic excesses than are women. Among 630 cases of heatstroke collected by the author in the summer of 1896 in New York City, 589 were men and but 40 women, and 1 child two and a half years old. Exposure to the direct rays of the sun is usually the exciting cause, though such exposure is not necessary, as some of the worst epidemics in India have occurred during the night, especially just before dawn. While soldiers on the march and laborers working in the sun have given the greatest number of victims to this disease, men working in superheated environments, such as firemen, stokers, bakers, and laundry-workers, have very often been attacked. In the tropics, where men realize the danger, proper precautions are taken to prevent sunstroke, but in the temperate climates, where the intense heat occurs only at intervals, such precautions as

suitable clothing and resting during the hottest hours of the day are neglected. This neglect causes at times a terrible mortality from this disease. During the summer of 1896 the writer was greatly impressed by these facts. The men brought to Bellevue Hospital overcome by heatstroke were usually clothed in heavy flannel underclothing and woollen outer clothing, and often added to these a flannel shirt and cotton "jumper." Such clothing as this, fit only for cool weather, undoubtedly prevented radiation and evaporation of heat from the body. Any cause which prevents the evaporation of the perspiration and hinders the refrigerating processes of the body directly tends to cause sunstroke. For this reason the warm moist climates are more conducive to this disease than hotter but drier climates. The main factors in the weather at any given time which are especially prone to cause insolation are a high humidity, a continuously high temperature, and lack of movement in the air: of these, humidity and absence of cooling breezes are as important factors as the high temperature, though the causation of sunstroke is usually attributed to the height of the temperature. In this manner is produced the hot, sultry, lifeless atmosphere which so many observers have noted as being present when sunstrokes were prevalent.

That vitiated atmosphere is not an unimportant factor is shown by the facts that among columns of infantry marching in close order more cases of sunstroke occur than when more open order is allowed, and more cases occur among men sleeping in crowded barracks and small tents than among those in well-ventilated quarters.

Sunstroke occurs with greater frequency among unacclimated individuals in hot countries than among those whose longer residence has given them a certain amount of immunity to the effects of heat. This immunity is not by any means absolute, as even the natives in India, Egypt, and the Arabs of the African deserts are at times overcome by the scorching hot winds and succumb to the "hot windstroke."

The Caucasian race is much more susceptible to the effects of heat than the dark-skinned races. Negroes, though not often attacked, are not exempt. The number of cases of heatstroke in the Northern army during the Civil War was—white troops, 6617, deaths 261; colored troops 583, deaths 58.

Another etiological factor, seldom mentioned, is the absence of drinking water with troops on the march. Jacubasch mentions that in a march from Bukkur to Dadur in India the Twenty third regiment, which had carried canteens filled with water, lost but 12 men from sunstroke, while the Bengal regiment, which had carried no water, lost 30 men. The water probably replaced the great loss of fluids from the blood and enabled the men to sweat, and thus keep cool by evaporation.

Injudicious diet and excesses in eating undoubtedly aid in causing sunstroke. It has even been claimed that sunstroke is especially liable to occur just after a hearty meal.

Pathological Anatomy and Pathology.—The post-mortem appearances following death from insolation depend somewhat on the time which has elapsed since death occurred. When the post-mortem examination is made shortly after death the following conditions are usually present: when the antemortem temperature has been high, the

PLATE II.

Nerve Cells in Cases of Sunstroke. (Van Gieson.)

PLATE III.

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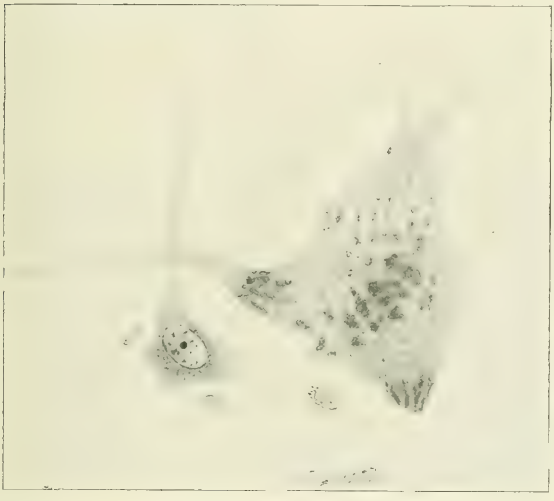

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Nerve Cells in Cases of Sunstroke. (Van Gieson.)

viscera feel notably hot. The left ventricle of the heart is contracted and empty, the right ventricle filled with semi-fluid blood, which sometimes gives an acid reaction; the lungs are congested, sometimes extremely so; the liver and large abdominal veins are filled with blood; the meninges and brain are often congested. When several hours have elapsed, decomposition has set in rapidly, and rigor mortis has occurred early. The left ventricle of the heart is not so often firm and contracted, and often the whole heart is flabby and filled with grumous, semi-fluid blood. The spleen is sometimes slightly enlarged and soft; the lungs and liver are congested. The meninges are congested with more or less abundant subpial fluid; the brain tissue itself is usually firm and not congested, with sometimes a little bloody fluid in the ventricles. The membranes of the spinal cord are congested; the cord itself is firm and of normal appearance. Small hemorrhagic extravasations are mentioned as occurring under the visceral pleuræ and pericardium. The most constant changes seem to be the marked congestion of the meninges and viscera, the fluidity of the blood, and the unusual rapidity with which rigor mortis and decomposition set in.

The gross pathological anatomy gives no constant and characteristic lesion of sunstroke, but in studying the minute cellular structure of the central nervous system we find certain definite and apparently characteristic lesions which seem to give us the most probable solution of the cause of this disease. To Ira Van Gieson of New York is due the credit of first designating these lesions in the neurons of the brain and spinal cord (Plates II. and III.). These lesions are described by Van Gieson as acute parenchymatous degeneration of the ganglion cells, and are best shown by the Nissl staining and counter-staining with eosin. In the normal cells stained in this manner the chromophylic plaques or so-called "Nissl bodies" appear to have a somewhat barrel-stave shape, and to be somewhat thickly packed in the body of the cell in regular positions. In insolation the appearances are strikingly different. In moderately early stages of the acute parenchymatous degeneration the chromophylic plaques are divided into larger and smaller segments, or in other places appear fused together in a confluent condition, or they show changes in form and have rounded ends or are oval-shaped or spherical, and are fewer in numbers. In still other cells the chromophylic plaques have been converted into fine dustlike particles which are strewn about over the cytoplasm and give it a finely granular or almost homogeneous appearance. The outlines of these cells are much less distinct than normal. These appearances seem to be more often found in the anterior horn cells of the spinal cord, where the changes do not seem to have advanced so far as in the cerebral cortex and cerebellum. When the changes are further advanced—as shown, for example, in the Purkinje cells of the cerebellum—the chromophylic plaques have not only been converted into fine dustlike particles, but in most of the cells even these particles have disappeared, giving to the cell body a faint, pallid, shadowy outline which is difficult to see without resorting to contrast staining, as, for example, with eosin. The changes in the nuclei in the Purkinje cells are also distinctly marked and radical. The nuclear membrane (karyotheca) has an uneven outline; it is notched in places, slightly crenated, and the nuclear fluid (karyolymph) or nucleus is changed in

consistence, so that it appropriates the methylene-blue stain very intensely. Thus the nuclear volume stands out very sharply in distinct contrast to the normal, which only slightly appropriates the methylene-blue. In some cells the nuclear contents appear homogeneous, while in others they are finely granular and contain small spherical granules (karyosomes), which are not normally present. The nucleus in some cells seems to have entirely disappeared. In none of the ganglion cells, however, which have so far been examined of the spinal cord, medulla, cerebellum, or cerebral cortex has there been any distinct evidence of destruction of the cells. There have been no vacuoles nor loss of substance of the cytoplasm. The cells preserve their form and shape, but exhibit various phases of dissolution and disappearance of the chromophylic plaques. In the cerebral cortex these changes occur in both the motor and psychic cells. The changes thus described, according to Van Gieson, are similar in every way to those produced by the operation of a great variety of poisons, including the extrinsic group such as lead, alcohol, etc., microbian poisons, and auto-intoxications both in human diseases and those induced experimentally in animals. There seems to be no other interpretation open as to the significance of this acute parenchymatous degeneration of these ganglion cells than the operation of a toxic substance on these cells. It is the evidence of a chemical reaction between a poison and the constituents of the cells. By the elimination method of excluding other groups of poisons, these changes having been found in the nervous systems of patients in whom alcohol can be positively excluded, it is justifiable to conclude that insolation is a species of auto-intoxication. This toxic resolution of the ganglion cells may not necessarily go on to the destruction of the cell, and is compatible with restoration and recovery of function and structure: this depends, however, upon the cessation of the poisons. In other words, in insolation there is a toxic cytolysis or cell-resolution of the neurons which depends upon the individual resistance of the body, the eliminative capacity of the body, and the duration of the action of the poison. Depending on these three factors, the neural parenchymatous degeneration may result in restoration or destruction of the neurons involved.

The changes in the cells of the other viscera also seem to be those of acute parenchymatous degeneration. These changes are especially noticeable in the liver and kidneys.

The blood in sunstroke undergoes certain marked changes. The number of red cells seems increased, according to Vincent, but this is probably only an apparent increase due to the condensation of the blood from loss of fluids from the excessive sweating. In examinations of the blood at Bellevue Hospital in the summer of 1896 the red cells appeared distorted. The hæmoglobin color-test in 12 cases gave from 85 to 125 per cent., averaging 100 per cent. The increase above the average normal was also probably due to the condensation of the blood. There was also destruction of the red cells, as the leucocytes contained pigment; and there was a leucocytosis present. The pronounced anæmia following sunstroke also proves the destruction of the red cells. These blood changes occurred not only in patients who were suffering from hyperpyrexia, but also in patients whose temperatures did not rise to 105° F. As the red cells do not disintegrate from heat till the tem-

perature reaches 125.6–129° F., the destruction observed in sunstroke points distinctly to some toxic element in the blood. The blood-serum of sunstroke patients also proved exceedingly toxic to animals. Levene and Van Gieson found that 9 c.c. injected into the ear veins of rabbits killed the animals in less than an hour. Normal human serum in such doses does not produce such effects.

The experiments of Vincent and Laveran show that in blood drawn during life in animals suffering from hyperthermia the gases of the blood, CO_2 and O_2, show no greater variation than in the normal blood of animals with normal temperatures. The experiments of Vallin and Claude Bernard, showing a great diminution of oxygen, are valueless, as they were made with post-mortem blood, and the post-mortem changes occur with almost incredible rapidity after death with hyperpyrexia.

Wood and other observers have reported that the blood of individuals dead of sunstroke was greatly diminished in its alkalinity, and in some instances was acid. Whether this acidity is due to post-mortem changes is not known. The alkalinity of the blood, however, is diminished in animals whose temperatures have been artificially raised either by brain puncture or by heating.[1]

Levene and Van Gieson found that the urotoxic coefficient was diminished in the urine from patients suffering from sunstroke, while it was increased in the urine from the same patients in the first twenty-four to forty-eight hours of their recovery. This seems to point to a failure in elimination of toxic substances during sunstroke.

Arloing has found that the sweat of individuals taking severe muscular exercise is two or three times more toxic than the sweat of these individuals when resting. When sweating ceases in sunstroke there will be an accumulation of these toxic substances.

Based on the above lesions and experimental observations, the clinical symptoms of the various forms of sunstroke are more readily explained and understood than by the theory that the heat alone within the body is the sole cause. The changes in the cytoplasm of the ganglion cells show the injuries to the functional potentiality of the cell, while the changes in the nucleus show processes which are detrimental to the life of the cell. The prodromal symptoms of the severe forms and the symptoms of the milder forms of sunstroke are those of acute functional disturbances, while the later symptoms of the severe forms show the tendency to destruction of the neurons.

Heat undoubtedly is the main contributing cause to sunstroke, as exposure to cold is the contributing cause to pneumonia. Whether the heat is derived from direct exposure to the sun's rays, or from the intense heat of the atmosphere at night, or from the artificial heat from furnaces, the mechanism of its action on the body is practically the same. Young men with healthy eliminating organs withstand without injury great changes of temperature and prolonged exposure to great heat. The even temperature of the normal body is obtained by the maintenance of the equilibrium between heat-loss and heat-production. This is secured by the contraction or dilatation of the skin capillaries and the decrease or increase in the perspiration, and the consequent

[1] *Virchow's Archiv*, vol. 145, p. 49.

decrease or increase in the radiation, conduction, and evaporation of heat from the body. There also seem to be nervous centres controlling the production of heat by inhibition, though their exact localization and action cannot be said to be finally determined. Normally, 2.6 per cent. of heat is lost from the body by warming the food and drink ingested; 2.6 per cent. by warming the inspired air; 14.7 per cent. by evaporation from the skin; and 80.1 per cent. by radiation and conduction from the skin. On the other hand, heat is produced by the chemic metabolism going on in the body, and especially during muscular exercise. Insolation occurs with the greatest frequency among those performing some form of bodily exercise in an intensely hot environment. The heat-production is at its maximum, while the heat-loss from warming the inspired air is *nil*, and the loss from radiation and conduction from the body in air as warm or warmer than the body is also reduced to a minimum or is nothing. The body is then cooled by evaporation alone, and in an atmosphere already heavily charged with moisture evaporation is greatly hindered. If sweating is excessive, the heat-loss may be sufficient to keep up the equilibrium between heat-production and heat-loss, but if sweating ceases, as it usually does in insolation, the heat-loss of the body will cease and heat-production, continuing heat, rapidly accumulates, and if from any cause the heat-regulating centres become paralyzed, the heat-production will become enormously increased, and some form of sunstroke will follow, and death will ensue when the vital functions can no longer continue at the high temperature. This is the whole mechanism of sunstroke considered from the standpoint of causation by heat alone; but it fails to explain either the action of heat on the body cells or certain features in the clinical history of sunstroke or the cause of death.

Recently Goldscheider and Flatau [1] have shown that the neurons of the central nervous systems of animals whose temperatures had been artificially raised to 109.4° F. or more show the same changes when stained by Nissl's method as have been described above. The neurons of living animals whose temperatures have remained for three hours at 107–107.6° F. also begin to show these same changes. But when an animal had been previously killed, and the temperature of the body immediately raised to 112.3° F., the cells did not change from their normal appearance, showing that the changes were produced by some vital action. Heat alone, therefore, will not produce these changes, and the action must be one of chemic metabolism in the cell protoplasm. The writer has seen several patients die of insolation whose temperature rose only to from 105.4–106.5° F. These temperatures in other diseases, such as pneumonia, typhus, sepsis, malaria, and typhoid, are borne without causing death; hence the amount of heat *per se* in the body did not cause the death of these patients; for if such amount of heat is dangerous to the organism, death should occur from such temperatures in other diseases; which is not the case. Heat alone, therefore, is insufficient to explain the cause of death in these cases. Most authors state that a temperature of 113° F. is necessarily fatal, but a patient suffering from sunstroke was admitted to the Presbyterian Hospital in New York with a temperature of 115° F., and recovered. The

[1] *Fortschritte der Medicin*, April 1, 1897.

limit, therefore, to which the body may be heated and recovery take place cannot be definitely stated. In infectious diseases it is the causal agent, not the temperature, which kills, and in sunstroke the metabolic changes in the central neurons, not the heat.

It would be unprofitable to enumerate here all the theories which have been advanced to account for the cause of death in sunstroke. While it is true that on the battlefield men have been known to drop from sunstroke, become rigid, and die almost instantly, as if there were a sudden coagulation of the cardiac muscle, the theory of Vallin that death is due to sudden heat coagulation of the left ventricle of the heart, the right side remaining flaccid, is untenable. In experiments on animals Laveran has found that the heart will again begin to beat if the thorax is opened in a cooler room than that in which death occurred. True heat coagulation is irreparable, and the heart's action could not recommence if such a change had occurred. The experiments of Ide show that in death at temperatures below 122° F. the heart muscle itself is unaffected. This investigator found that hearts heated to 120° F. would be brought to a standstill in their action, this being due to metabolic changes in the composition of the muscles caused by the abnormal temperature, with absolutely no injury to their structure. This accumulation of harmful products can be removed by the oxygen of the hæmoglobin. If the heart, however, is heated above 122° F., a partial coagulation of its muscle takes place, which causes irreparable disturbances in the heart's activity. The highest temperature ever recorded in insolation, that of 117.8° F., is well below the temperature at which even partial heat coagulation occurs in the cardiac muscle. The rigidity of the left ventricle found after death from insolation is due to post-mortem changes, which occur with extreme rapidity. Death is therefore not due to coagulation of the heart muscle, nor is it due to lack of conduction in the nerve fibres, as these do not lose their power of transmitting impulses till a temperature of $125\frac{3}{5}$° F. is reached. It is due to some toxic action on the cardiac and respiratory centres at whatever temperature it may occur.

It is difficult to say whether respiratory or cardiac failure is the first to occur. In the experiments of Vincent on animals, which are the most accurately recorded of all the experiments on this point, the respiration invariably ceased before the heart. Clinically, while in the majority of cases there is a simultaneous failure of heart and respiration, the respiration seems to cease first, though at times there seems to be a sudden cardiac syncope.

As will be seen later, the prodromal symptoms of insolation are those of functional disturbances of the digestive tract and liver. Food is badly assimilated or is partially undigested, and there is a catarrhal inflammation of the intestines; not infrequently a slight jaundice develops. Abnormal substances are thus produced in the digestive tract and absorbed, or the disordered liver may fail to break down the substances brought to it from the digestion. This mild form of auto-intoxication gives the headache, malaise, and anorexia. When severe muscular exercise adds its decomposition products to the substances already circulating in the system, and heat accumulates, as has already been explained, oxidation and chemical changes take place with great

rapidity, and at such high temperatures unusual chemic combinations may be formed; at all events, substances which ordinarily are not present in the blood or are eliminated accumulate rapidly, and the neurons undergo changes which finally bring on unconsciousness and the symptoms of severe insolation. The cessation of sweating which prevents heat-loss from the body and elimination of certain toxic substances is not easily explained. Whether it is simply due to loss of water from the blood which the previous excessive sweating has brought about, or due to lowered blood pressure in the widely dilated skin capillaries, or whether the cessation of the glandular secretion is from a change in the nervous centres, is difficult to decide.

The milder forms of sunstroke known as heat prostration or exhaustion are due, therefore, to a mild form of auto-intoxication, and are but the prodromal period of the severer forms, and do not develop further, the neurons being but functionally disturbed. If the intoxication is more severe and the neurons more severely poisoned, syncope and unconsciousness occur, but the heat-loss due to the great dilatation of the skin capillaries is sufficient to prevent accumulation of heat. Heat-loss may so predominate over heat-production that with the nervous exhaustion collapse and subnormal temperature may occur. The pulse in these forms, except in collapse, remains of good force and tension; that is, the heart's action and blood pressure are still sufficient to keep up a good cutaneous circulation. This is of great importance, as Winternitz has shown that stasis in the skin capillaries is capable of causing a retention of over 94 per cent. of the heat which would be given off with an active cutaneous circulation.

When the intoxication is very severe unconsciousness may develop suddenly with or without prodromal symptoms, and the vaso-motor, cardiac, and respiratory centres are affected, heat-loss being abolished and heat-production and accumulation being at a maximum, the enormously high temperatures develop. The neurons are poisoned so severely that their functions are abolished, and the symptoms of destructive action, convulsions, delirium, coma, and death, supervene.

Symptoms.—The heat prostration or exhaustion is the mildest form of sunstroke. As Wood says: "The sense of weakness which often accompanies exertion in feeble persons during hot weather represents in the mildest possible form the condition under consideration." When heat exhaustion occurs among more vigorous individuals the condition is usually more pronounced. The prostration may come on suddenly without prodromal symptoms, but more often there are distinct prodromal symptoms before complete prostration occurs. These are usually headache, dizziness, and pain in the back and legs or in the epigastrium, with sometimes tingling in the hands and feet. These symptoms may continue for a few hours or for three or four days, and are sometimes accompanied with anorexia, nausea, and vomiting and great thirst, with diarrhœa or constipation: sometimes a distinct jaundice of the whites of the eyes is noticeable. The perspiration at times ceases, but this is not common in the milder forms of sunstroke. During the continuance of these prodromal symptoms the patients are able, as a rule, to sleep at night and wake refreshed, but as soon as they go about the symptoms recur, and after a varying length of time the prostration is so extreme

that the patient succumbs: the headache is intense, either frontal or occipital, and the patient seems dazed. Consciousness is retained. The respirations are but slightly increased above normal—from 24 to 28 per minute. The pulse may remain of normal frequency or may run up to 130–140 per minute. It is of good force and tension, and does not vary in ratio to the height of the temperature, but depends more on the condition of nervous exhaustion. The temperature may be normal or even slightly subnormal, though there is usually a rise of temperature which may reach 104.8° F. The temperature may go to normal after a few hours, and the other symptoms abate and the patients recover. Or the symptoms may continue longer, and there may be a slight thermic fever for two to five days or more, the temperature ranging from 99° to 103° F., and gradually fall to normal. I have seen such a slight fever continue for fifteen days. These patients do well and recover.

In the moderately severe forms of insolation there is always a loss of consciousness, but the temperature does not reach the hyperpyrexial level of 105° F. Persons suffering from this form of sunstroke have at times the same prodromal symptoms as in heat prostration; at other times there is added a feeling of intense burning heat, or "pins and needles," in the head; sometimes there are alternate hot and cold feelings over the entire body, with sweating. Severe vomiting and anorexia are often marked. Perspiration usually ceases before unconsciousness occurs. In some patients just before consciousness is lost there are sudden dizziness and dyspnœa, sometimes with chromatopsia. In other patients there are no premonitions of the attack, and there is sudden loss of consciousness. These symptoms usually develop while the patients are at work, though they may develop suddenly while the patient is quietly walking in the street at night. A suicidal tendency is sometimes developed: sailors overcome by heat in the tropics have endeavored to throw themselves overboard; among troops on the march men have attempted suicide with their own muskets. A patient who came under the writer's notice attempted to tear his chest open with the jagged fragment of his drinking cup, which he had broken on his iron bedstead. This patient after two weeks' time recovered completely. In some cases of this class there are all the symptoms of complete collapse—pale face, delirium, unconsciousness, shallow respirations, feeble almost imperceptible pulse, and subnormal temperature.

Wood reports a case in which the temperature was 95° F. in the mouth. Rectal temperatures of 96° or 97° are not uncommon in this class of cases. The majority of these patients, however, when first brought to a hospital for treatment have a slight rise of temperature, about 101° F., at times as high as 104° F. When the temperature on admission is low, 99–101° F., it is apt to rise afterward to 103–104.8° F. The pulse may be normal or may be as frequent as 130 per minute, and except in cases of collapse it is full and of fair tension. The respirations are more rapid than normal, from 20 to 40 per minute, and are quiet, but are usually shallow. The tongue is coated white, the skin hot and dry or covered with sweat; the patients are unconscious or have been so, and are partially conscious, with an intense headache. The pupils still react to light, though sometimes dilated. The patients

may have convulsive movements and restless delirium, moaning and groaning as they toss about. Not infrequently there is a peculiar dark pink petechial rash on the body, which differs in its appearance from the ordinary prickly-heat rashes with which the bodies of many of these patients are covered. The blood changes previously mentioned occur in this form of sunstroke as well as in the hyperpyrexial form. The unconsciousness, delirium, and other symptoms persist till after a cool bath or even for some hours longer; sometimes consciousness will not be regained for twenty-four hours. The thermic fever persists for several days or a week. This class of patients usually recover.

This seems to be the least common form of sunstroke. In 224 cases of the different varieties of sunstroke which came under the writer's notice at Bellevue Hospital in 1896, there were but 18 cases of this kind.

The severest form of insolation is the hyperpyrexial. In this class are included all patients whose temperature rises to 105° F. or above, whether consciousness be retained or not. The prodromal symptoms when present are often more prolonged than in the other two classes, lasting sometimes for a week, though there are more cases in this class which have no prodromal symptoms. This absence of prodromal symptoms is more common in patients whose temperature rises above 108° F. than in those with lower temperatures. The worst cases, therefore, may occur suddenly without any warning, so far as the patient is able to remember after he has regained consciousness.

Some of the prodromal symptoms are the same as in heat prostration and in the moderately severe cases of insolation. The insomnia, however, is marked, being present, as a rule, for three or four days before the attack. There is often great irritability and restlessness. There is sometimes a decided increase in micturition for several days. Sweating almost invariably ceases in these severe forms. Just before consciousness is lost there is often a feeling of burning heat throughout the body or only in the head—a feeling as if the head would burst open or as if the eyes were bulging outward. To some patients all objects suddenly seem blurred, while to others they seem bathed in different colors—red, yellow, green, blue, or brilliant white. In this chromatopsia blue is the color most often seen. In other patients all objects suddenly lose color and appear black.

Previous to loss of consciousness there are sometimes hallucinations of hearing and sight. Oberneier reports a case of a soldier who suddenly discharged his musket, and on being asked the reason declared that he had just seen a stag rush by him and had heard his officer order him to shoot it. He shortly afterward was overcome with an attack of sunstroke and died.

The suicidal mania may develop in this form of sunstroke.

Several patients who have been under the writer's care were seen by their friends to keep at their work, managing complicated machines, for half an hour or longer after they had ceased to answer questions or to pay any regard to their surroundings, before they fell to the floor in coma. Others have been known to leave their work, go to their homes, bathe, change their clothing, and go out again on the streets, where they have been picked up comatose, yet when full consciousness returned they could remember nothing after leaving their work. Although ap-

parently unconscious of what they were doing, they were able to perform complex acts in an intelligent and voluntary manner.

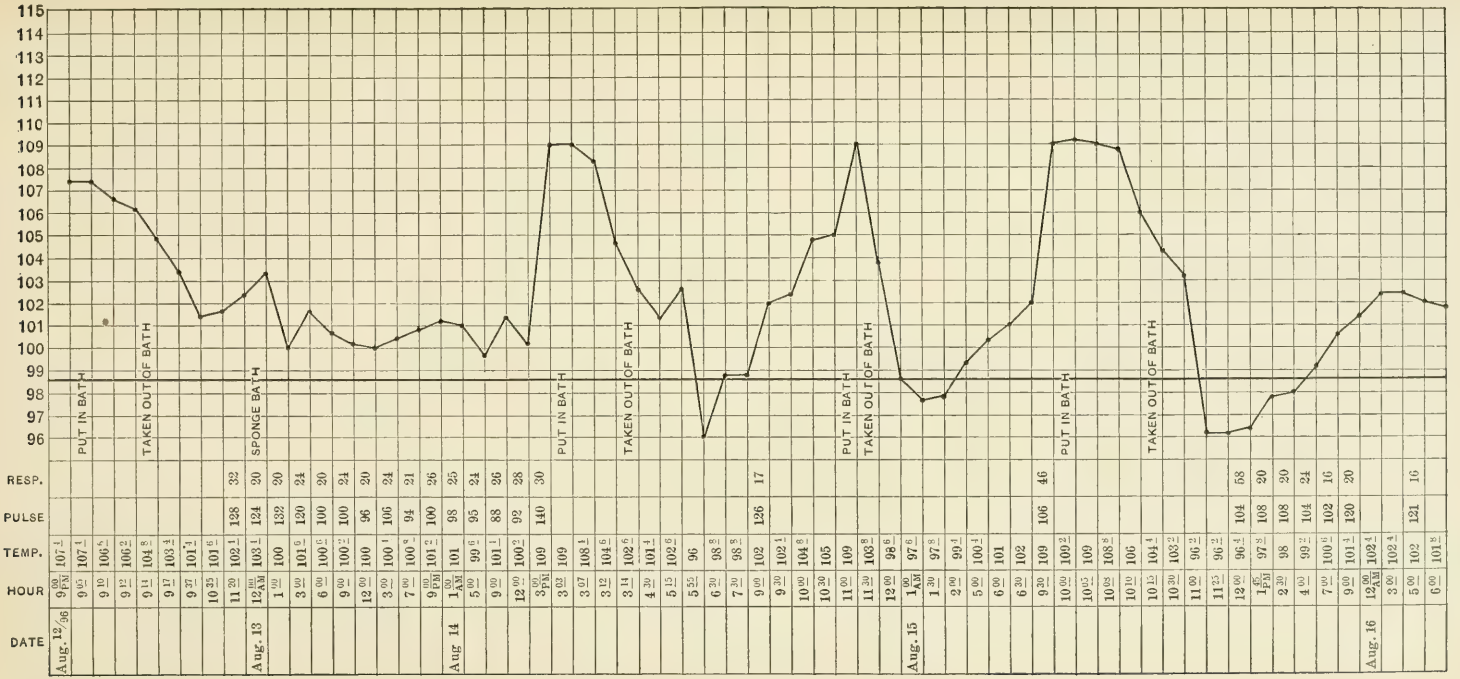
When consciousness is retained the patients complain of an intense headache and of the burning heat, or they are stupid and dazed. The retention of consciousness, however, is the exception: most patients are comatose; the skin is dry, flushed, and hot, or is cool, livid, pale, or cyanotic, with a clammy perspiration. The eyes are suffused and half open or staring and filmy with a glazed, set look. The pupils are sometimes normal, more often contracted or dilated, sometimes evenly so, sometimes unevenly. They may or may not react to light. Their lower jaw twitches convulsively; the mouth is gaping open. The respirations come in short gasps, often irregularly, with either a noisy gasping inspiration and quiet expiration, or a quiet inspiration and explosive expiration, each expiration being at times accompanied with a piteous moan or groan. Some patients lie absolutely limp and flaccid, not moving even an eyelid, while in others the muscles twitch convulsively, or this twitching is replaced by violent epileptiform convulsions. Often they are wildly delirious, and fight and struggle furiously. The pulse is usually soft, frequent, and rapid, often small and thready; it may be full and strong, with throbbing carotids. The worst cases are pulseless. Vomiting and involuntary defecations are very common. The urine is scanty, and, Wood reports, sometimes albuminous—others say that it sometimes contains blood. The peculiar petechial rash is often present, most abundant on the body and arms. The bodies of these patients emit a characteristic and peculiarly disagreeable and penetrating odor, and, though it is especially strong in the fæces, it is quite different from a fecal odor.

Some authors divide these cases into two clinical types, one type being those with flushed, dry, hot skin and active delirium and convulsions, or without convulsions and with coma; the other type, those with pale, cyanotic skin and flaccid, relaxed muscles. These types shade into each other, and are not dependent on the height of the temperature, though the relaxed type occurs most frequently with temperatures above 109° F.

The exceedingly high temperature is a most characteristic symptom. The highest temperature recorded is 117.8° F. in a patient who was brought to the New York Hospital in August, 1896. Another patient had a temperature of 115° F. (Fig. 67, p. 888) at the Presbyterian Hospital in New York during the same epidemic. These temperatures were measured with special thermometers. Temperatures of 112–113° are not uncommon, and those of 108–110° are very common (Fig. 64, p. 884, and Figs. 65, 66, p. 887). The rapidity with which the highest point of registry was reached in the ordinary thermometer with severe cases leads the writer to suspect that temperatures above 112° F. occur more frequently than is usually supposed. The table (p. 885), compiled from 246 histories in possession of the writer, shows the temperatures in these cases.

The quality of the pulse is an excellent criterion of the severity of the attack. There is no regularity in the ratio between the frequency of the pulse and the height of the temperature. The writer has seen the pulse vary from 90 to 150 per minute with temperatures of 110° F., and from 96° to 150° with temperatures of 105° and 106° F., the number

FIG. 64.



Insolation temperature record, showing relapses.

of respirations varying from 16 to 50 per minute with the same temperatures. As a rule, however, the most severe cases have the highest temperatures, the most frequent and compressible pulse, and the most rapid and shallow respirations.

118° F.	1 died		Total, 1
115° F.		1 recovered	" 1
112–113° F.	5 died;	3 recovered	" 8
111–112° F.	3 died;	2 recovered	" 5
110–111° F.	23 died;	22 recovered	" 45
109–110° F.	20 died;	38 recovered	" 58
108–109° F.	15 died;	26 recovered	" 41
107–108° F.	7 died;	20 recovered	" 27
106–107° F.	3 died;	29 recovered	" 32
105–106° F.	1 died;	27 recovered	" 28
Totals	78 died;	168 recovered	246

Consciousness is not usually retained at any temperature above 106° F. In the above 246 cases, in every instance in which the consciousness or unconsciousness of the patient is mentioned, and in which the temperature was 110° F. or over, coma was complete. In one patient, whose temperature was 109° F., consciousness was sufficiently retained, so that he could be partially roused. With temperatures of 108–109° F., 1 patient was conscious, 3 partially so, and 30 unconscious; with temperatures 107–108° F., 6 were conscious and 21 unconscious; with temperatures 106–107° F., 8 were conscious and 21 unconscious; with temperatures 105–106° F., 11 were conscious and 11 were unconscious.

In the most severe cases death rarely occurs immediately, but is delayed for a few hours. Even when properly treated, however, the course of the disease is very varied, and patients are by no means out of danger as soon as the temperature has been reduced. The means of reducing the temperature by hydrotherapy will be discussed later. When the temperature has been reduced to nearly normal, whatever the means employed, consciousness returns in about half the cases, either immediately or within an hour, and is usually retained. Others do not regain consciousness after the first bath, but after their temperature rises again and a second bath is given, consciousness returns, and they remain rational. Many patients, however, remain unconscious for twenty-four hours or three or five, or even ten days, and yet recover. In the worst cases, even after the temperature has fallen, the patients still have a frequent, compressible pulse, dyspnœa, and often cyanosis; they remain unconscious, and usually die within twenty-four hours. Some of these, however, will live longer, perhaps for a few days, and die without regaining consciousness.

But even after consciousness has been regained and the patients are apparently doing well, at the expiration of a few hours or one or two days delirium and unconsciousness not infrequently develop, and they may remain delirious for a few days or a week, and then recover, or they may die during this delirium.

In patients whose initial temperature has been between 105° and 107° F., after the temperature has been reduced it usually remains down, and they go on to an uninterrupted recovery without a thermic fever or any abrupt secondary rises of temperature. This exceptionally occurs when the initial temperature has been from 107–110° F. But when it

has been above 110° F. there are one or more secondary rises of temperature (Fig. 64, p. 884, and Figs. 65 and 66, p. 887), which usually require some active measures of reduction. Some patients die when the temperature is reduced, irrespective of the height from which it has fallen, before a secondary rise occurs. Most patients, however, who die succumb with the first or second rise, or fail to react after these secondary rises have been reduced. Still others may have three, four, or five rises of temperature before they succumb. One patient with an initial temperature of 108° F. had nine exacerbations up to 104–105° F. during the forty-eight hours before he died. On the other hand, most of the patients who finally recover, but who have these secondary rises, have only one or two rises, the two rises being less common than the single rise. They may, however, have three, four, or five distinct thermic exacerbations.

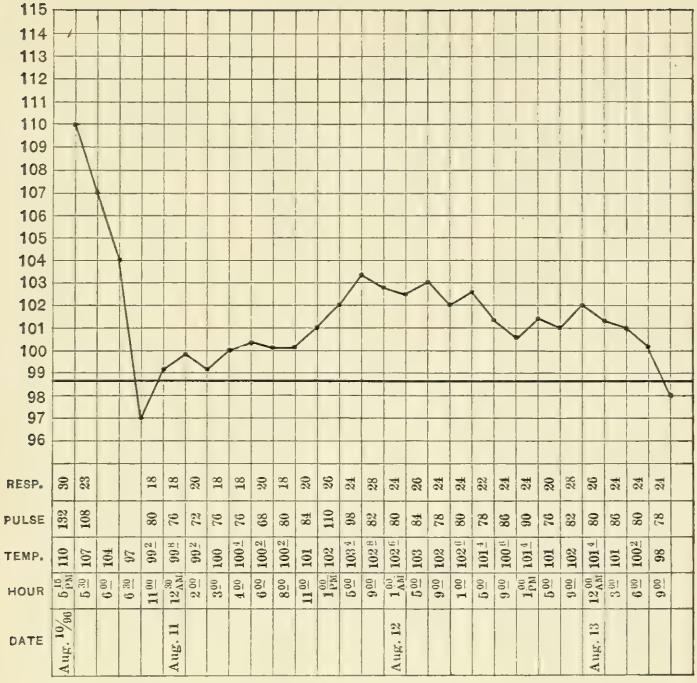
The first secondary rise of temperature occurs most frequently three to six hours after the first bath; next in frequency, between twelve to eighteen hours. In serious cases the first rise occurs within three hours or even within an hour. The second rise occurs most often between twenty-four and thirty-six hours after the bath given to reduce the initial temperature; less commonly it occurs in from twelve to eighteen hours afterward. In severe cases this second rise occurs in from three to eight hours after the first bath and in two to three hours after the first secondary rise; that is, many patients will require active measures to reduce their temperature three times during the first twenty-four hours following their attack of insolation. For when the third rise of temperature occurs it is in severe cases from the ninth to the twelfth hour after the first bath, though in many cases it does not occur till the second or third day. The fourth and fifth rises occur, as a rule, during the second, third, or fourth days of the thermic fever. Many patients have a thermic fever without exacerbations sufficiently high to require interference, the temperature ranging only from 100–103° F. Sometimes this fever averages a little higher, and is easily controlled by sponge baths. This fever may continue for from three to five days or from one to three weeks (Figs. 67, 68, pp. 888, 889; Fig. 69, p. 890; Fig. 70, p. 891).

The pulse improves, both in force and frequency, after the bath, except in the fatal or very severe cases, in which it remains thready, feeble, soft, and very frequent. In the favorable cases it falls, as a rule, more slowly to normal than the temperature. After a few days, however, even if there be a moderate thermic fever, it usually averages from 80 to 90 per minute.

Bloody expectoration sometimes occurs during or just after the bath, and less often bloody stools. Retention of urine requiring catheterization is not uncommon.

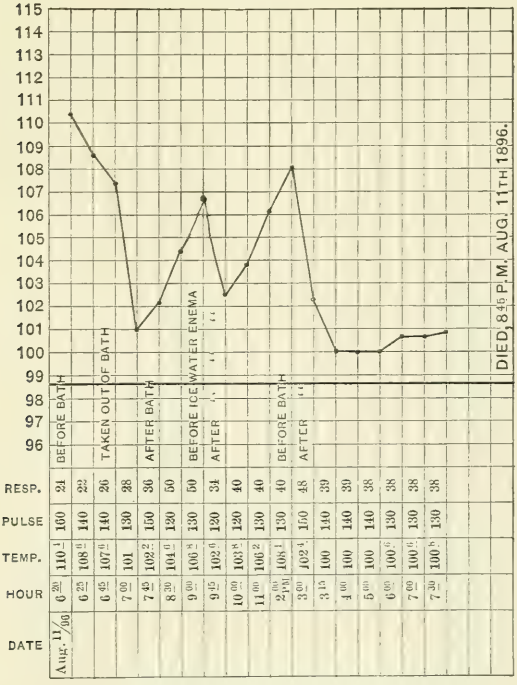
Convulsions occur in the severe cases, and are not dependent on the height of the temperatures. The writer has seen severe convulsions in patients with temperatures of 105.6° or 106° F., as well as with 108–112° F. Since these convulsions depend on the toxic cytolysis of the central ganglion cells, they are always a serious symptom, though by no means a fatal one. The convulsions may be of a severe general epileptiform type, or they may be confined to the head and neck or arms and legs. They may be more pronounced on one side of the body than on the other, or, rarely, they may be distinctly unilateral. They occur

FIG. 65.



DATE	HOUR	TEMP.	PULSE	RESP.
Aug. 10/96	5 15 PM	110	132	30
	5 30	107	108	23
	6 00	104		
	6 30	97		
	11 00	99 2	80	18
Aug. 11	12 30 AM	99 8	76	18
	2 00	99 2	72	20
	3 00	100	76	18
	4 00	100 4	76	18
	6 00	100 2	68	20
	8 00	100 2	80	18
	11 00	101	84	20
	1 00 PM	102	110	36
	5 00	103 4	98	24
	9 00	102 8	82	28
Aug. 12	1 00 AM	102 6	80	24
	5 00	103	84	26
	9 00	102	78	24
	1 00	102 6	80	24
	5 00	101 4	78	22
	9 00	100 6	86	24
	1 00 PM	101 4	90	24
	5 00	101	76	20
	9 00	102	82	28
Aug. 13	12 00 AM	101 4	80	26
	3 00	101	86	24
	6 00	100 2	80	24
	9 00	98	78	24

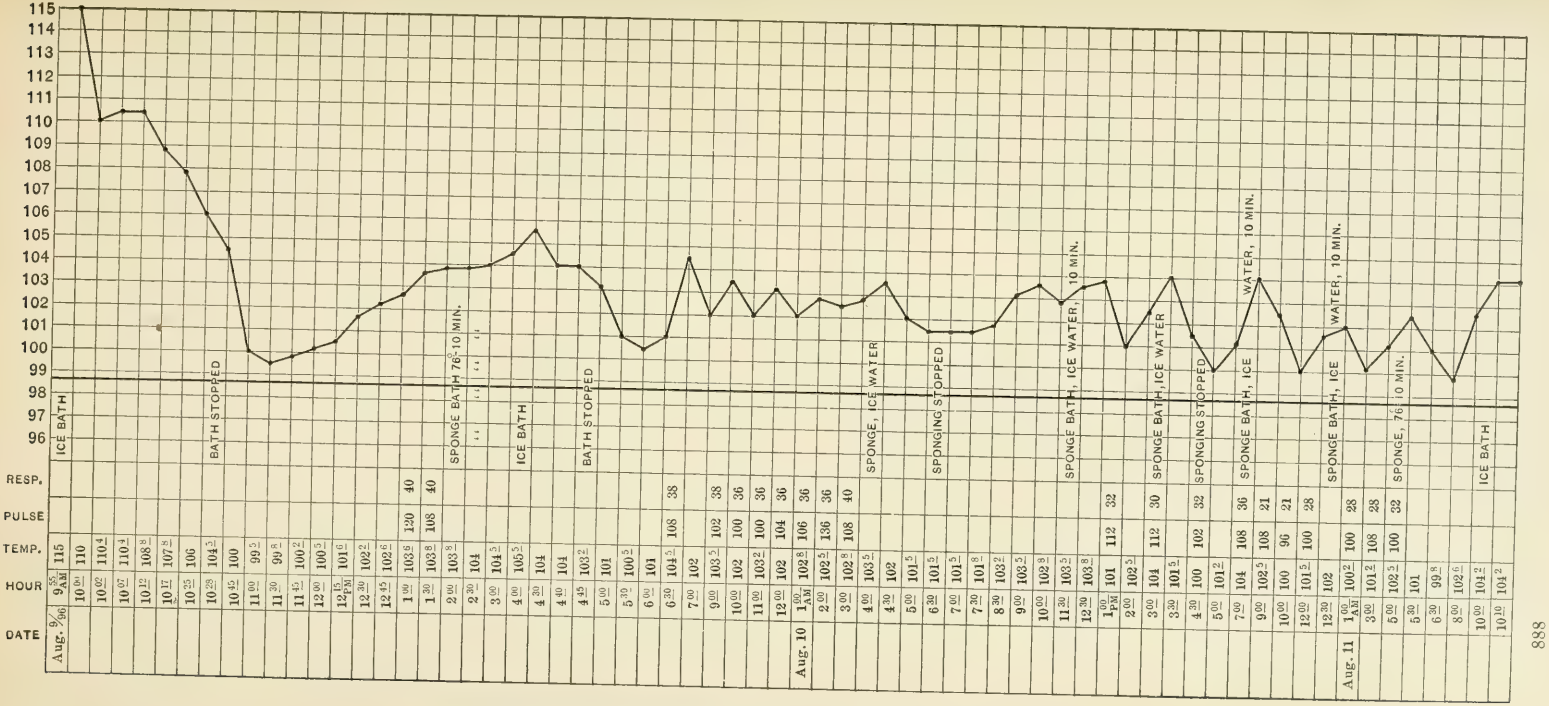
FIG. 66.



DATE	HOUR	TEMP.	PULSE	RESP.	
Aug. 11/96	6 20	110 1	160	24	BEFORE BATH
	6 25	108 8	140	22	
	6 45	107 6	140	26	TAKEN OUT OF BATH
	7 00	101	130	28	
	7 45	102 2	150	36	AFTER BATH
	8 30	104 6	130	50	
	9 00	106 8	130	50	BEFORE ICE WATER ENEMA
	9 15	102 6	120	34	AFTER " "
	10 00	103 8	120	40	
	11 00	106 2	130	40	
	2 00 PM	106 1	130	40	BEFORE BATH
	3 00	102 4	150	48	AFTER "
	3 15	100	140	39	
	4 00	100	140	39	
	5 00	100	140	38	
	6 00	100 6	130	38	
	7 00	100 6	130	38	
	7 30	100 8	130	38	

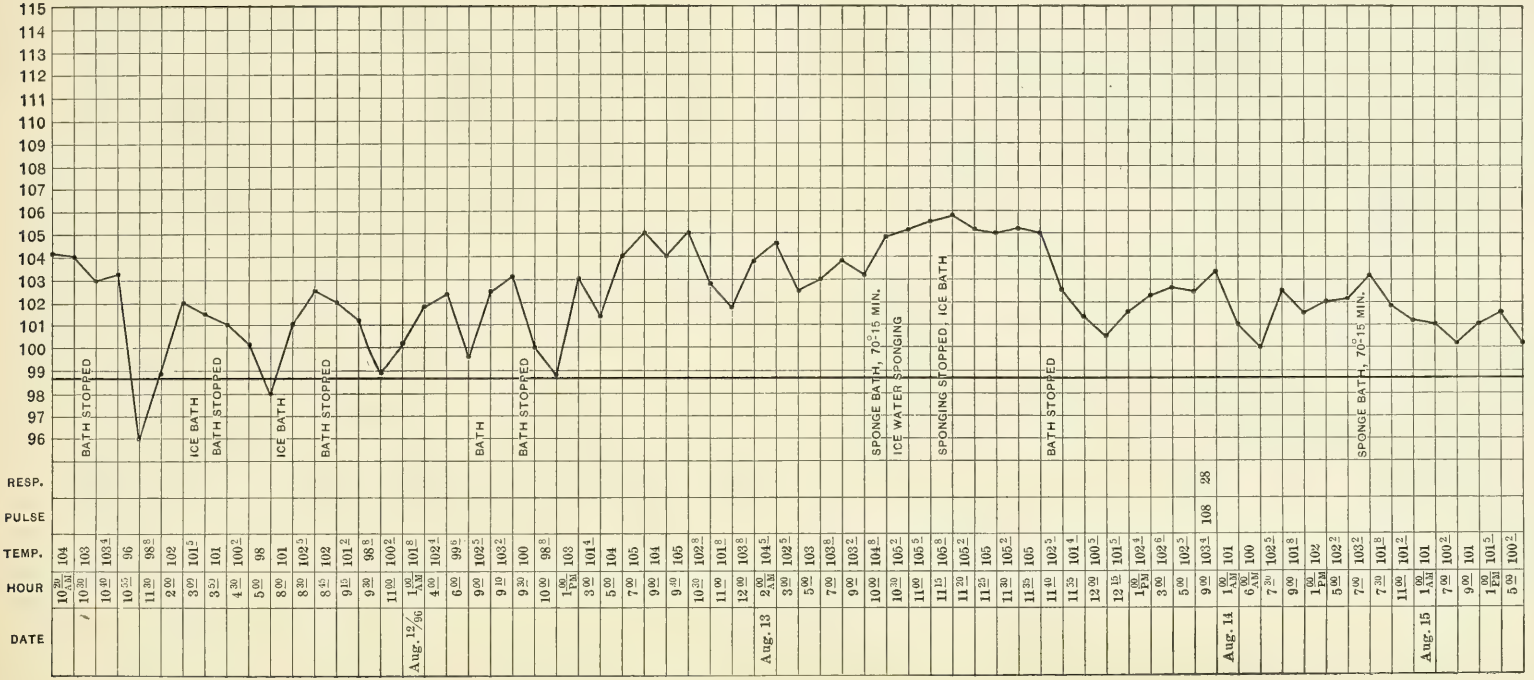
Insolation temperature records.

FIG. 67.



Phenomenally high temperature record, showing subsequent continued fever.

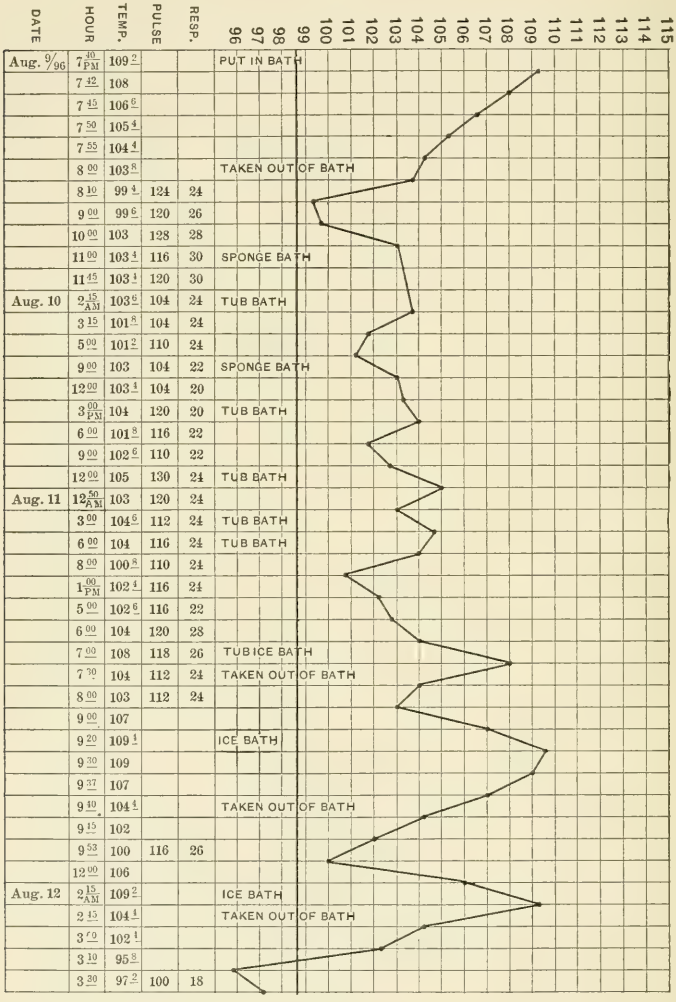
FIG. 68.



Continuation of Fig. 67.

usually with the acme of temperature, but they may not develop till some hours after the temperature has fallen. When a patient is in convulsions before the first bath they are apt to continue for some time afterward, though they may cease shortly after the temperature has fallen. At times a second bath of a few minutes will cause them to cease. After they have disappeared and the patient has been rational

FIG. 69.

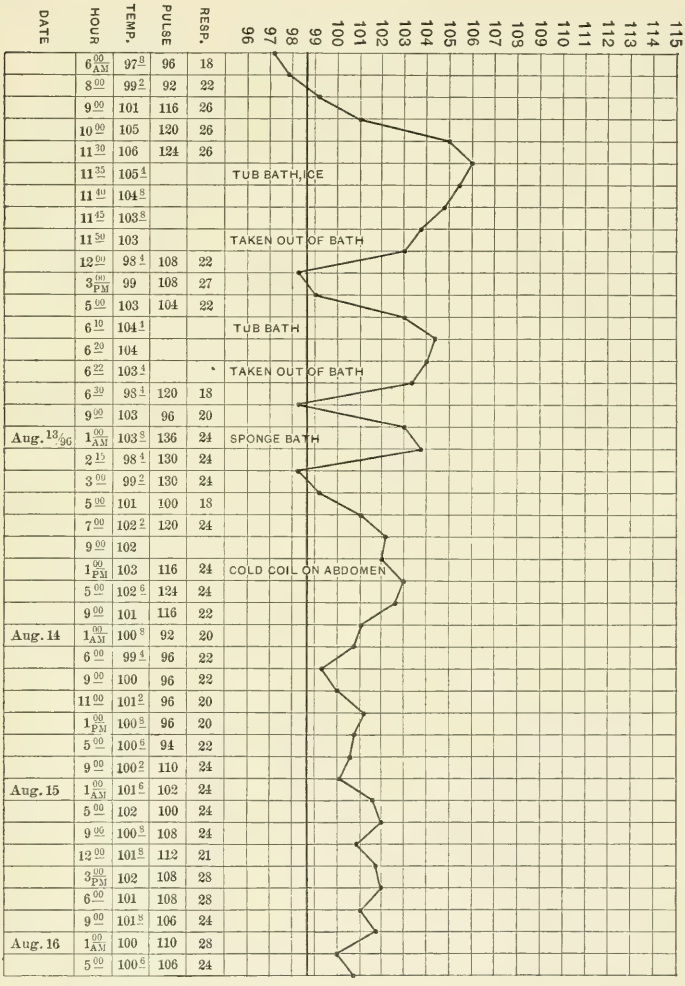


for hours, or even one or two days, convulsions may suddenly recur, and the patient may die in one. This, unfortunately, is not a very rare occurrence. The muscular twitchings which do not develop further into convulsions are exceedingly common. An intense rigidity of the muscles, similar to a tetanic spasm, is of quite frequent occurrence; this usually relaxes as the patients improves and sleeps. This spasm

may be of dangerous import to life, as the respiratory muscles may be involved, and when it comes on suddenly, as it occasionally does, there is great danger of suffocation. It may be so severe that artificial respiration is impossible.

In these cases of hyperpyrexia the skin often becomes dry and harsh, and during the week following the sunstroke a desquamation over the whole body may occur, the skin peeling off in fine scales or large flakes.

FIG. 70.



Ecchymoses are common in patients who bruise themselves in their delirium or convulsions, and these ecchymoses are much more extensive than is usual in the case of ordinary bruises. Large ecchymoses not infrequently follow hypodermic injections, and these may go on to suppuration.

A few patients develop an asthenic typhoid condition following insolation which deserves special mention. The writer has seen five such cases at Bellevue Hospital in Dr. Jackson's and his own wards. They were all strong, robust men with a marked alcoholic history. The initial temperatures were not excessively high, varying from 106.2–109° F. They all reacted well after their first bath, and became conscious immediately after the bath, or within four hours, and remained rational for twenty-four hours. They then became delirious, three of them wildly so, at first fighting every one who came near them, and then sank into a low muttering delirium. Two sank into the low delirium without having passed through the wild stage. Their skin became harsh and dry, their emaciation rapid and extreme, and they had incontinence of urine and fæces. Their half-closed eyes, hollow, sunken cheeks, and extreme general emaciation presented in a few days a striking picture compared with their well-nourished appearance on admission to the hospital. During the wild delirium their temperature rose to a high point, frequently equalling their initial temperature, with a pulse of 120 to 150. But at first, during their low delirium, the temperature of all five patients was from 99–102° F., and the pulse from 80 to 100. Finally, the pulse again became frequent (120 to 130), and the temperature in three cases rose ante-mortem to 106° and to 110° F. In two it did not rise. These patients died in from three to eighteen days after their sunstroke.

Complications.—Among the complications occurring with insolation are meningitis and delusional insanity. There may be delusions of persecution or hallucinations of various kinds. One patient under my care developed the idea that the other patients and the nurses were in league with the Mafia and were determined to poison him. Once, after medicine had been given him, he seized his urinal and drank the contents, endeavoring to cause an emesis. After six weeks this patient became apparently sane, and remembered nothing that had occurred during his illness. Pneumonia sometimes develops, and is usually fatal. In patients with chronic nephritis and the so-called large white kidneys acute suppression and uræmia may develop, or, if they have contracted kidneys, dyspnœic attacks and gradual emaciation and death. Fayrer mentions that cerebral hemorrhage may also follow sunstroke.

Sequelæ.—The immediate sequelæ of sunstroke are—headache, often very persistent, with periods of exacerbation; extreme weakness and malaise, dizziness, and soreness in the muscles and bones; and frequently numbness and tingling in the hands and feet. This tingling lasts for days or even weeks or months. The anæmia is usually extremely marked. The sequelæ which develop shortly after sunstroke and remain permanent or develop some months after an attack are polyuria and glycosuria or diabetes mellitus, chronic meningitis with intense headache, sometimes with stiffness of the cervical muscles or an encephalitis, with inco-ordination of the extremities so severe that the patient may be unable to feed himself. This may be accompanied with a highly emotional condition and dementia. Multiple neuritis may develop; sometimes a permanent atrophy of a certain group of muscles, as, for instance, the flexor muscles of the forearm; various forms of insanity, such as general paresis, mania, or delusional insanity

or dementia. Patients may have a changed disposition from good-natured to ugly and irritable. Sensitiveness to heat and dizziness with headache are probably the most common sequels. Chromatopsia on hot days may also occur. Epilepsy may arise, or, if already present, the fits may occur with increased frequency. Loss of memory and inability to concentrate their minds force some patients to give up their positions. One cook under the writer's care a year after his sunstroke reported that he had developed epilepsy, and, though he could formerly take and fulfil ten separate orders, he could then only take one at a time, and was liable to forget that. The percentage of those who become insane is larger than is generally supposed. Fayrer reports 19 cases of various forms of insanity occurring from sunstroke in India. In the 74 patients who had suffered from sunstroke at Bellevue Hospital in 1896, and could be traced nine months later, 3 had become permanently insane, though 42 had suffered from no sequelæ and were in their usual good health.

Diagnosis.—Heat exhaustion may be confounded with internal hemorrhage, cardiac failure, or alcoholism. But the intense headache of which the patients complain will help to diagnosticate heat prostration. The moderately severe forms of insolation, especially with the subnormal temperature, restless delirium, or collapse, must also be diagnosticated from internal hemorrhage or cardiac failure: the intensity of the delirium and the twitching of the muscles, if it be present, will aid in recognizing the condition. When unconsciousness is present the diagnosis from apoplexy, with its slow, full pulse, stertorous breathing, normal temperature of the skin, and local paralyses, can easily be made, because in sunstroke we have the soft, frequent pulse, shallow breathing, slight rise of temperature, hot, dry, flushed skin, and absence of local paralyses. The hyperpyrexial form is more easily distinguished. It may be confounded with meningitis, malaria, or abscess of the brain with extremely high temperature. The excessive height of the temperature, the peculiar respirations, the convulsive twitchings or intense convulsions, or the absolute immobility of the patient, with cool skin and high temperature, the history of the patient, and his previous environment, should render the diagnosis comparatively easy.

Prognosis.—The prognosis of heat prostration is universally good. Of the moderately severe forms of sunstroke it is also good, as they almost always recover. The prognosis of the severe forms depends on the previous habits or condition of the patient. In alcoholics or those weakened by disease the prognosis is worse than in robust, abstemious patients. In individual cases the pulse is the best criterion on which to base the prognosis. In general, however, the height of the temperature serves as a fairly good criterion. When the temperature is 111° F. or over the prognosis is very unfavorable, though by no means hopeless. With the temperature between 110° and 111° F., if proper treatment can be applied quickly, about 50 per cent. should recover. If the proper treatment is not applied, very few recover with temperatures above 108° F. In patients with temperatures between 108° and 110° F., under good treatment, 75 per cent. should recover. With temperatures above 105° and below 108° F. the mortality is about 12 per cent. These figures are based on the results of the extensive use of hydro-

therapeutics in the hospitals of New York City during August, 1896. In 520 hyperpyrexial cases the death rate was 25.38 per cent., both treated and untreated. Among those who lived long enough to receive treatment the mortality was 25.12 per cent. In 805 cases of all forms of insolation the mortality was 16.39 per cent. The mortality as usually given is from 41 to 50 per cent. In 926 cases reported in Aiken's *System of Medicine* the mortality was 56.62 per cent. The prognosis of insolation depends more on the rapidity with which treatment is applied and the kind of treatment employed than in any other disease.

Treatment.—When a person is overcome and prostrated by the sun's rays he should be conveyed to a shady and as cool a place as is possible to find at the time, his clothes loosened, and his head bathed with cool water, a little alcoholic stimulant of some kind given him, and he should be allowed to rest for some time. This usually will be sufficient. When the prostration is severe and the headache intense, the patient should be put to bed when possible, cracked ice applied to his head, his face and chest bathed with cool water, and some form of alcohol in a cool drink given him. If the temperature is normal or above, some one of the antipyretic coal-tar drugs can be given with advantage to ease the headache, such as 5 gr. of phenacetine or 10 gr. of antipyrine or 4 gr. of antifebrine. This will greatly alleviate the headache and tend to reduce what slight rise of temperature may be present. After a few hours of rest and sleep recovery will usually be found to be complete.

When collapse and subnormal temperature are present, the patient should be put to bed, covered up warm with blankets, and, if the condition is severe, hot-water bags or bottles packed around on the outside of the blanket. If the patient can swallow, a half ounce of whiskey or its equivalent should be given, and if necessary 5 gr. of caffeine or a teaspoonful of aromatic spirits of ammonia or Hoffman's anodyne. If unconscious, and hypodermic medication be necessary, $\frac{1}{30}$ or $\frac{1}{60}$ gr. of strychnine and $\frac{1}{100}$ gr. of glonoin, and 1 or 2 minims of the fluid extract of digitalis, or 1 to 2 gr. of a 10 per cent. solution of camphor in ether, can be used to advantage.

If the temperature is 103° or 104°, and the patient is unconscious, with convulsive twitchings, he should be placed in a cold pack or cold bath and vigorously rubbed for a few minutes, and then dried and put to bed and covered up warm; the same stimulation as above should be used and the patient allowed to rest. If the nervous symptoms are not marked, even if the patient is unconscious, with a temperature of 104–107° F., an ice-water enema, with a little common salt added (a teaspoonful to a pint of water), so as to irritate as little as possible the mucous membrane of the gut, can be given with beneficial effect. A pint or quart of such an enema is usually sufficient. Within an hour after such an enema has been given the temperature usually drops to about 101° F., and the patient feels greatly improved. If the enema causes a free movement of the bowels and the temperature remains high, it can be repeated into the empty bowel. These ice-water enemata are excellent, but they will not control a rising curve of temperature.

The hyperpyrexial cases demand some form of active and vigorous

hydrotherapy to reduce their temperatures. There is no disease which demands more immediate and active treatment, or which will respond more satisfactorily when proper means are instituted. In considering what is the best form of hydrotherapy the so-called law of Winternitz should be considered. As has been already mentioned, this author has shown that the venous stasis and congestion of the skin capillaries cause a retention of over 94 per cent. of the heat which can be given off from the surface of the body. Hence the law, that the greater the physical irritation causing increased circulation in the skin the greater the amount of heat given off. In giving cold baths, therefore, or cold packs, some form of ceaseless and untiring friction is *absolutely necessary*, both for the safety of the patient and in order to obtain the desired results. In addition to the reduction of the temperature the cold causes a tremendous stimulation to the poisoned nervous system, and two desirable objects are thus obtained.

For the above reasons it seems that warm baths are not as effective as cold, and the results obtained have not been as good. The so-called ice pack is also not as good as a full cold bath or cold pack, as will be described later. The ice pack is given by placing a patient on a rubber sheet and packing large pieces of ice along and between the legs and along the sides of the body. The surface of the body is then rubbed with the hands and pieces of ice. This procedure often requires an hour to reduce the temperature, and when the temperature is allowed to fall to 101° F. it almost always goes to subnormal, 95.5–96° F., which is to be avoided. The amount of friction used here is insufficient to obtain the best results. When the ice cold bath is used it should be given as follows: A large tub, such as is used for bathing typhoid-fever patients, is half filled with water, and moderate-sized pieces of ice are constantly kept floating in it. The temperature of such a bath is about 40° F. During an epidemic of sunstroke such a bath should be kept constantly prepared, and just before the patient, stripped of all clothing, is lowered into it the ice must be removed, and after a minute or two, when the water becomes slightly warmed by the patient, a half bushel of cracked ice should again be poured in, and as it melts more should be added. If there be no bath ready, the patient should be put into the ordinary tap water and the ice added *after* the patient is in the bath. Under no circumstances should the patient be lowered into the floating ice, as under these circumstances a few patients will have a sudden muscular rigidity and cannot be revived. This is, however, a rare occurrence, but it does happen. When, however, the patient is lowered into the cold water without the ice or into ordinary tap water, such extreme muscular rigidity does not ensue, and what muscular stiffening may occur can soon be overcome by vigorous rubbing. From the moment the patient is in the water till he is lifted out the most vigorous rubbing of the entire body with the hands or rough mittens must never cease. Rubbing with a sponge is insufficient, and should not be allowed. The patient's head should be supported and the cold water constantly sponged over it. When such a bath is properly given the cyanotic appearance of the skin quickly changes to a rosy pink, and the pulse improves in frequency and tension. The respirations become deeper and less frequent. Consciousness may return in the bath itself.

When consciousness is returning or when the patients are delirious, they fight and struggle furiously, and it requires as many assistants to hold as to rub them. The bath should be continued until the rectal temperature of the patient falls to about 103° F.: if it be allowed to fall much lower, it is sure to become subnormal and the reaction afterward is more severe, and the secondary rise, if it follows, will then come much sooner. The length of time necessary to reduce a high temperature by these baths varies to such an extent that it is impossible to give even an approximation for any temperature. It depends more on the amount of heat being produced than on the height to which the temperature has risen. I have seen a temperature of 106° F. remain at the same level for twenty minutes, and a temperature of 110° F. come down to 102° F. in eight or nine minutes. The thermometer should therefore be kept in the rectum, and the temperature should be noted at least every two minutes. For the same reason a set time, such as ten minutes, should not be used as a limit for the continuance of the bath irrespective of the temperature.

Some patients do not bear these baths well, and should be taken out and placed in a cold pack. After the patient has been taken out he should be rubbed dry and placed between blankets, and hot bottles placed around him and an ice cap put on his head. Stimulants will often be required, and the hypodermic medication spoken of above is the best. Hoffman's anodyne and aromatic spirits of ammonia, when given hypodermically, are apt to produce ecchymoses which may go on to suppuration. All drugs, whether to stimulate the heart or to quiet the delirium, do not seem to act at these high temperatures, and it is not until the temperatures are reduced that they will show their usual effects. It is a good plan, therefore, to give with the heart stimulants, while the patients are in the bath, $\frac{1}{8}$–$\frac{1}{4}$ gr. of morphine with $\frac{1}{250}$ of atropine, which will quiet the convulsions and delirium and produce sleep in a short time after the patients are put in bed.

The cold pack, followed by the hot pack, is carried out as follows: The patient is stripped as rapidly as possible and wrapped in a cotton sheet, and placed on a stretcher covered with a rubber sheet. Dipperfuls of ice water are forcibly dashed against the patient from a distance of several feet. In very severe cases every few minutes a small stream of ice water is allowed to fall from a height of six or eight feet and strike the patient on the forehead between the eyes. This is powerfully stimulative, and such treatment should be kept up until the rectal temperature is 104° or 103° F. The patients should be then wrapped in blankets, surrounded by hot bottles, and allowed to rest. The reaction under this treatment is not so marked as with the ice baths, and the hot pack often, after a short while, brings on sweating. This plan of treatment was carried out under O'Dwyer in St. Vincent's Hospital, New York, and in 197 hyperpyrexial cases there was a mortality of only 10.15 per cent.

Another excellent means of reducing the high temperature and simultaneously stimulating the patient is by means of the needle spray. The patient is placed naked on a cot or stretcher covered with a rubber sheet, an ice cap tied to his head, and he is then vigorously sprayed with tap water by means of hose with nozzles giving a fine needle

spray. This is continued till the rectal temperature falls to 103° F. The patient is then wrapped in blankets. When the secondary rises occur the process is repeated till the temperature falls to 101° F. Of the 26 patients treated in this manner at the Flower Surgical Hospital, New York, 3 died,—a mortality of 11.5 per cent. These last two methods have the advantage of being easily applied with a few assistants. The ice bath requires six or eight assistants to hold and rub a patient thoroughly. It is tiresome, and is also very painful to the hands and arms of the assistants, and a sufficient supply of ice may not always be available.

The question of bleeding the patient often arises. In cases of strong, full-blooded patients with full, bounding pulse and throbbing carotids it is sometimes beneficial. In less sthenic cases it should never be performed, as it is sure to do more harm than good.

The subcutaneous injection of warm saline solutions in amounts of one or two pints is sometimes very beneficial and stimulating. It also replaces the great loss of fluids which has taken place.

The secondary rises of temperature must be combated with the same methods of hydrotherapy as the initial temperatures whenever the temperature rises to 105° F. or above. When there is a thermic fever without any abrupt rises, it may often be controlled by a cold-water coil on the abdomen or by placing bladders filled with ice on the groins and in the axillæ. These means, in the writer's experience, have seemed to be more effective in women than in men. The ordinary cool sponge bath is also often sufficient. Liquor ammonii acetatis in half-ounce doses every hour for a few hours is often of great help in the thermic fever, as it produces both a diaphoresis and diuresis. It should be freshly prepared, as it is useless when more than forty-eight hours old.

The convulsions are often extremely difficult to control. Sometimes a second cold bath is effective. Sometimes morphine, gr. $\frac{1}{8}$ to $\frac{1}{4}$, and gr. $\frac{1}{100}$ hyoscin, will control them. Sometimes a few whiffs of chloroform are effective.

The sudden rigid spasm of the muscles which threatens to cause suffocation may sometimes be overcome by dropping one or two drops of amyl nitrite on the nasal mucous membrane. Respiration will sometimes begin again and the muscular spasm relax. This drug is of great benefit in sudden collapse of the heart and respiration, which not infrequently occurs. Artificial respiration, persisted in for half an hour or an hour, will at times cause respiration to begin again. This is especially useful where the respiration fails before the heart's action.

The insomnia and nervousness in alcoholics during their thermic fever are often overcome with doses of bromides and chloral, 30 gr. of the former and 15 gr. of the latter at a dose. Morphine in $\frac{1}{8}$- to $\frac{1}{4}$-gr. dose, with 15 gr. of chloral, is at times better. Trional in 15-gr. doses, and repeated several times if necessary, is at times of use in this condition.

The anæmia and other after-effects of sunstroke require careful treatment of a tonic character. The small doses of the tincture of iron—*i. e.* 3 drops in a tumbler of water, taken with meals—have proved, in the writer's experience, by far the most effective method of giving iron. There are no constipating effects, no disturbances of

digestion, and the appetite and anæmia have rapidly improved under this treatment. This may seem minute dosage, and in opposition to the generally accepted idea of the more iron the greater the effect. The large doses pass off in the fæces as sulphide of iron, and are not absorbed, and constipate and cause disturbances of the stomach, while the smaller doses with meals are absorbed and produce no disturbances. Cod-liver oil in teaspoonful doses, with $\frac{1}{60}$ gr. of strychnine, is also excellent in these cases. The malaise and anorexia immediately following sunstroke are often quickly relieved by the following:

℞. Tincturæ nucis vomicæ, ℥ss;
Tincturæ cinchonæ compositæ,
Tincturæ gentianæ compositæ, āā. ℥jss.—M.
Sig. One half to one teaspoonful after meals.

The nervous depression and the tingling in the hands and feet are often benefited by a Charcot-needle douche to the spine every day or every other day.

The more severe sequelæ, such as diabetes and multiple neuritis, should be treated as is customary for such diseases arising from other causes. The insanities are apt to be permanent, and when sending such patients home from tropical countries the possible suicidal tendencies should be remembered, and they should not be allowed to go alone.

The only means of securing permanent recovery from the sequelæ in many cases which have developed in the tropics is to send them to some cooler climate, as they become chronic invalids unless such a change of habitat is made.

The chronic meningitis which at times develops is often benefited, according to Wood, by the actual cautery. The persistent and merciless use of it is often necessary. Internal medication of mercurials and potassium iodide is also indicated in these cases.

Complete recovery from the sequelæ is often long deferred, and it may be years before exposure to heat can be withstood without the recurrence of headache and prostration.

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